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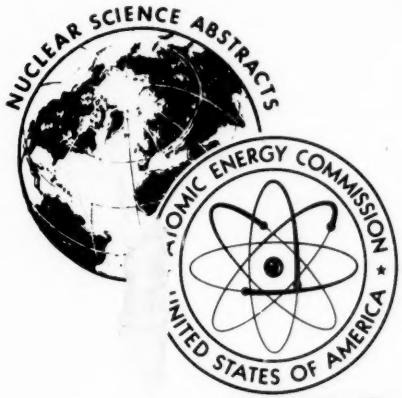

NUCLEAR SCIENCE ABSTRACTS

Volume 20 Number 1

Abstracts 1–1580

January 15, 1966

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NOTICE

The following changes have been incorporated in *Nuclear Science Abstracts* beginning with Volume 20, Number 1:

(1) Scope Definitions

a. The third statement under "Biology and Medicine" has been expanded to include "laser and maser beams."
b. The second statement under "Radiation Effects" should now read: Only biological effects of ultraviolet radiation and laser and maser beams.

(2) Subject Category Definitions

a. The subcategory "Radiation Effects" has been separated into two subcategories "Radiation Effects on Biochemicals" and "Radiation Effects on Tissues."
b. The subcategory "Meteorology" has been added to the main category "Geology and Mineralogy" and the main category "Meteorology" has been discontinued.
c. The subcategory "Criticality Studies" under "Physics" has been discontinued and such information will be categorized to the purpose of the study.
d. The subcategory "Field Theory and Quantum Mechanics" has been replaced by "Field Theory, Scattering Theory, and Symmetries."
e. Two new subcategories have been added for "Fluid Physics and Thermodynamics" and "Gravitation, Quantum Mechanics, and Relativity Theory."
f. The subcategory "Power and Power-Breeder Reactors" has been redefined to exclude dual-purpose reactors. Information on dual-purpose reactors will appear in the subcategory "Process Heat Reactors."

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Volume 20, Number 1, January 15, 1966

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Division of Technical Information, Edward J. Brunenkant, Director.
Published by the USAEC Division of Technical Information Extension, Robert L. Shannon, Extension Manager.

Nuclear Science Abstracts covers the international literature on nuclear science and technology and provides the only comprehensive abstracting and indexing of this body of information. Published twice each month since 1947, *NSA* covers technical reports of the U. S. Atomic Energy Commission and its contractors, technical reports of U. S. Government agencies and other governments, universities, industrial and research organizations, as well as patents, books, and journal literature on a world-wide basis. Nearly 350,000 abstracts have appeared in *NSA* through Volume 19. The subject matter covered in *NSA* is described in issue Number 1 and in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the U. S. Atomic Energy Commission, Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37831.

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ACKNOWLEDGMENTS

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TABLE OF CONTENTS

Volume 20, Number 1, January 15, 1966

Category	*Page*
BIOLOGY AND MEDICINE	1
General	1
Ecology	3
Metabolism, Tissue Distribution, and Toxicology	4
Radiation Effects on Biochemicals	7
Radiation Effects on Tissues	9
Radiation Effects Therapy and Countermeasures	21
Radiation Hazards and Protection	23
Radiotherapy and Radiodiagnosis	25
CHEMISTRY	35
General	35
Analytical Procedures	36
Inorganic and Physical Chemistry	42
Organic Chemistry	51
Radiation Chemistry	53
Radiochemistry	61
Separation Processes and Procedures	63
ENGINEERING	67
General	67
Applications of Nuclear Explosions	68
Facilities and Equipment	69
Heat Transfer and Fluid Flow	69
Materials Testing	71
Protective Structures	71
Space Propulsion	71
Vacuum Engineering	72
GEOLOGY, METEOROLOGY, AND MINERALOGY	74
General	74
Meteorology	74
Natural Radioactivity and Fallout	75
Site Survey and Selection	78
Techniques and Equipment	78
Thorium and Uranium Minerals	80
HEALTH AND SAFETY	81
INSTRUMENTATION	93
General	93
Radiation Detection	96
Radiation Effects	101
ISOTOPE TECHNOLOGY	102
General	102
Industrial Applications	102
Power Application	105
Separation and Production	106
MATHEMATICS AND COMPUTERS	107
METALS, CERAMICS, AND OTHER MATERIALS	108
General	108
Corrosion	110
Fabrication	113
Properties and Structure	116
Radiation Effects	125
PHYSICS	130
General	130
Accelerators	132
Astrophysics and Cosmology	134
Atomic Physics	135
Cosmic Radiation	138
Direct Energy Conversion	139
Elementary Particles and Radiations	139
Field Theory, Scattering Theory, and Symmetries	146
Fluid Physics and Thermodynamics	149
Geophysics	150
Gravitation, Quantum Mechanics, and Relativity Theory	152
Low Temperature Physics	153
Neutron Physics	155
Nuclear Properties and Reactions	157
Plasma Physics and Thermonuclear Processes	168
Shielding	175
Solid State Physics	178
REACTOR TECHNOLOGY	182
General	182
Auxiliaries and Components	183
Criticality Studies	188
Design and Feasibility	190
Fuels	191
Power and Power-Breeder Reactors	193
Process Heat Reactors	202
Propulsion and Space	202
Research and Test Reactors	202
WASTE DISPOSAL AND PROCESSING	205
GENERAL AND MISCELLANEOUS	207
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-10
SUBJECT INDEX	INDEX-41
REPORT NUMBER INDEX	INDEX-105
CATEGORY DEFINITIONS	APPENDIX-1
SCOPE NOTES	APPENDIX-9
JOURNAL LIST	APPENDIX-25

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, May 20, 1963

Volume 20, Number 1 January 15, 1966

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstracts 218 and 340.

1 (BNL-9363) KINETICS OF PROLIFERATION OF NORMAL AND LEUKEMIC LEUKOCYTES. Cronkite, Eugene P. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 24p. (CONF-650443-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Wistar Inst. Symposium on Human Leukemias, Philadelphia.

Granulocytopoiesis investigations by application of ^{3}HTdr labeling of DNA and subsequent serial cytologic and autoradiographic studies in man are reviewed. Contributions to the study of human leukemia are discussed, and preliminary observations on the application of extracorporeal irradiation of the blood in the study of lymphopoiesis and leukemia are presented. (H.G.D.)

2 (EUR-2419.f) ETUDE DE LA CONSERVATION ET DE LA STABILITE DES MACROMOLECULES MARQUEES. (Study of the Conservation and Stability of Labelled Macromolecules). Braeyens, W.; Charles, P.; Davila, C.; Huart, R.; Ledoux, L.; Zamorani, G. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1965. 26p. Dep. mn.

The results on methods of preparing and storing labelled molecules relate to: (1) the preparation, properties, and storage of nucleic acids labelled by biological synthesis or by tritiation in vitro; and (2) the study of the properties and storage of ribonuclease and lysozyme at high specific activity. (D.L.C.)

3 (LF-23) EXPERIMENTAL ANIMAL HOUSING FOR THE FISSION PRODUCT INHALATION PROGRAM. Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Aug. 1965. Contract AT(29-2)-1013. 29p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The facilities for holding and supporting the experimental animal colonies designed and constructed as a portion of a building complex comprising the AEC Lovelace Fission Product Inhalation Laboratory are briefly described. These included kennels and a metabolism building for dogs, rooms for small animals, and a colony support building incorporating isolation wards, a diagnostic laboratory, a surgical suite, and diagnostic x-ray equipment. (auth)

4 (LF-26) SUSCEPTIBILITY OF TISSUE CULTURES OF CANINE ORIGIN TO VIRUSES. Pindak, Frank F.; Clapper, William E. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Aug. 1965. Contract AT(29-2)-1013. 21p. Dep. mn; CFSTI $0.50 cy, $0.50 mn.

The suitability of tissue cultures of canine origin for isolation of viruses from dogs was studied. Primary cultures of kidney, lung, heart, and whole dog embryo, low-passage tracheal cells and a continuous line of epithelial-like cells derived from dog kidney were challenged with 27 viruses. These included the infectious canine hepatitis virus, two coxsackie A and six coxsackie B viruses, three types of polioviruses, ten ECHO viruses, one adenovirus, the western and eastern strains of equine encephalitis virus, and A and B strains of influenza virus. Although each type of cells supported the growth of one or more viruses as evidenced by the cytopathic effect, none of them appeared to be more suitable for virus isolation studies than HeLa and monkey kidney cells. (auth)

5 (NYO-901-37) NEW ENGLAND DEACONESS HOSPITAL SUMMARY PROGRESS REPORT (PART III), APRIL 1, 1950–APRIL 30, 1965. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). Contract AT(30-1)-901. 117p. Dep. mn; CFSTI, $4.00 cy, $0.75 mn.

Brief summaries are presented of results of radiobiological studies and studies using radioisotopes as tracers in various physiological studies conducted over a 15-year period. A list is included of 403 publications during the period. Separate abstracts were prepared for 7 sections of this report. (C.H.)

For abstracts of individual sections see: 57–62 and 232.

6 (NYO-3319-7) FACTORS INFLUENCING RADIORESISTANCE OF MICROORGANISMS. Technical Progress Report, January 1–September 15, 1965. Bruce, Alan K. (State Univ. of New York, Buffalo. Dept. of Biology). Sept. 24, 1965. Contract AT(30-1)-3319. 25p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Progress is reported on work continued on: ultraviolet modification of Micrococcus radiodurans by p-hydroxymercuribenzoate (HMB); x-ray dose response of HMB binding in M. radiodurans, S. lutea, and E. coli; the effect of phase state on dose-modification by MEA and HMB in bacteria; and identification of protective compounds in M. radiodurans. New approaches during the report period included localization of bound HMB and extraction of DNP from M. radiodurans. (H.G.D.)

7 (ORNL-3883) SEMIANNUAL CONTRACT PROGRESS REPORT TO THE NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS DISEASES, MARCH 1–SEPTEMBER 15, 1965. Anderson, N. G.; Cline, G. B. (Oak Ridge National Lab., Tenn.). Oct. 1965. Contract W-7405-eng-26. 45p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Progress is reported on the application of zonal centrifugation in virology and vaccine production. The isolation of adenovirus antigens in a state suitable for use as an experimental vaccine was investigated. Preliminary result indicated that virus subunits can be banded in density gradients in zonal rotors. Research on respiratory syncytial virus (RS) was designed: to determine whether the infectious virus could be disrupted into antigenically active subunits that would stimulate the production of neutralizing antibody, or whether the intact virus particle would be necessary for an effective vaccine; and to find a centrifugation technique

that would permit rapid and efficient isolation, concentration, and purification of infectious RS particles from liter-volumes of harvest culture. The latter objective was realized with the development of an isolation technique using the newly developed B-IX continuous flow zonal rotor. Routinely, better than 99.99% of the infectious particles were removed from the harvest fluid and between 80% and 90% of these infectious particles can be recovered in a single zone in a comparatively small volume. Attack on the first objective of the RS project was in efforts to disrupt the intact virus under controlled conditions for ultrastructural studies. Problems arising from daily operation of the sterile isolation system necessary for virus isolation by zonal centrifugation and the efficacious use of such systems for production of useful vaccines are discussed. (H.G.D.)

8 (STI/DOC/10/42, pp 23-43) HEALTH PHYSICS AND RADIATION PROTECTION. (International Atomic Energy Agency, Vienna (Austria)).

Seven research contracts using ^{47}Ca in studies of calcium metabolism were completed: rickets, diagnosis of metastatic bone lesions, rate of bone remodelling in normal and fractured long bone in vitro and in vivo studies with bone-seeking isotopes, diagnosis of skeletal lesions, calcium metabolism in bone diseases, and bone metabolism in man. Three other contracts also summarized are: use of bone marrow grafting in treatment of irradiated people and in animal experiments, mammalian retention of radioactive Sr, and protective effects of phosphate polymers in living cells against gamma radiation. (D.L.C.)

9 (STI/DOC/10/42, pp 61-9) RADIOISOTOPE APPLICATIONS IN AGRICULTURE. (International Atomic Energy Agency, Vienna (Austria)).

Two research contracts were performed on fertilizers. In the first, studies were made of the solubility product, dissolution rate, and isotopic exchange kinetics of raw phosphate, and pot and field experiments on Hyperphos and basic slag were conducted to study the direct application of raw phosphate to soils. In the second, ^{15}N and ^{32}P were used in field and greenhouse experiments on the utilization of nitrogen and phosphorus fertilizers by maize. (D.L.C.)

10 (TID-21261) COMPARATIVE STUDY OF INTERSTITIAL CELL TUMORS OF RAT TESTIS INDUCED BY CADMIUM INJECTION AND BY VASCULAR LIGATION. Gunn, Samuel A.; Gould, Thelma Clark; Anderson, W. A. D. (Miami Univ., Fla. Dept. of Pathology). [1964]. Contract AT(40-1)-2023. 27p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The induction of interstitial cell tumors (ICT) in rats by cadmium administration was compared with ICT-induction by vascular ligation. One year following ligation surgery or cadmium injection, the rats were prepared for hormonal evaluation by determining the capacity of the dorsolateral prostate to take up administered ^{65}Zn. Since cadmium injury produces, in a sense, a selective chemical ligation of the testicular vasculature, a comparison was made between the ICT resulting from total vascular ligation (spermatic plus vasal vessels), from partial vascular ligation (spermatic vessels only) and from cadmium injection. The incidence of ICT formation varied from 68 to 77 percent one year following surgical vascular ligation or cadmium injection; there was no significant difference between the various tumor-induction methods with regard to the incidence of ICT. Although the ICT formed by the three tumor-induction methods studied were indistinguishable morphologically, they did exhibit different endocrine characteristics. In rats bearing ICT resulting from total vascular ligation, there was no evidence of a discernible androgen output. In contrast, in rats with ICT induced by partial vascular ligation, there was definite evidence of androgenic function, although less than in non-tumor bearing control animals. The ICT induced by cadmium injection were also androgenically functional to the same degree as the tumors which resulted from partial ligation. Although zinc was known to prevent the formation of ICT induced by cadmium, it did not alter the development of ICT induced by either partial or total vascular ligation. (TCO)

11 (AEC-tr-6293) PROCEEDINGS OF THE TASHKENT CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY. VOL. III. Turakulov, Ya. Kh. (ed.). Translation of Trudy Tashkentskoi Konferentsii po Mirnomu Ispol'zovaniyu Atomnoi Energii, Akademiya Nauk Uzbekskoi SSR, 3: 1961. 863p. Dep. mn; CFSTI $8.75 cy, $3.50 mn.

A total of 113 papers are included which presents results of investigations using radioisotopes and radiation in the fields of medicine, biology, and agriculture. Among the topics treated are radiation effects, formation of iodinated compounds in the organism when radioiodine is used, the functional state of the vascular system, exchange processes, and metabolism during radiation sickness. (D.L.C.)

12 A SURVEY OF WORK WITH RADIOISOTOPES. Mertl, F. (Charles Univ., Plzen, Czechoslovakia). Acta Univ. Carolinae Med., Suppl. 20, 86-7(1964).

A brief history, with bibliography, is given of radioisotope research at this institution. The Institute of Medical Physics began studies with isotopes in the early 1960's when several types of apparatus were developed for the detection of radioactive radiations. In 1956, a second laboratory was established and equipped for detecting all the generally used radioisotopes. The activities of the Institute were initially directed to developing methods of dosimetry by means of G-M tubes, ionization chambers, scintillation counters, as well as of personal dosimetry devices. These methods were applied to studies of the radioactivity of the environment. Cooperation with other institutes of the Medical Faculty resulted in development and construction of new apparatus (e.g., a medical gammagraph with suppressed background registration) as well as the distribution, processing, and final measurement of labeled compounds used for chemical and biological experiments. For example, ^{32}P was used for labeling bacteria, the distribution of which was followed in rabbits; DNA and bacteriophages were also labeled with radiophosphorus. The efficiency of various substances capable of increasing resistance to external radiation was also studied as well. The radioisotopes ^{115m}Cd and ^{203}Hg are being used in the research on the metabolism of toxic substances. By means of ^{52}Mn, the mechanism of manganese transport from the liver into the bile and the digestive tract in guinea pigs was investigated. Radioautochromatography was employed in addition to the usual counter detection methods. Incorporation of ^{32}P into the brain damaged during the early postnatal period was also examined. A higher level of ^{32}P in the brain cortex as well as in the brain stem was found in animals sacrificed more than 8 hr after the administration of the isotope. (BBB)

13 THE IMAGING PROPERTIES OF SOME MICRO-AUTORADIOGRAPHIC METHODES. Hartmann, G.; Herrmann, W. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Atompraxis, 11: 445-9(Aug. 1965). (In German).

A critical study of the concept of local resolving power shows that it is inadequate for a complete description of the imaging properties of autoradiographic methods. Reference is made to the contrast-factor which occurs in discussions of contrast transfer theory. Methods for obtaining contrast-factors are listed, and such factors are determined for certain special methods. (auth)

14 EFFECT OF DEUTERIUM SUBSTITUTION ON THE TEMPERATURE OF THE HELIX-COIL TRANSITION IN DNA. Salganik, R. I.; Knorre, V. L. (Inst. of Cytology and Genetics, Academy of Sciences, Novosibirsk, Siberian SSR). Biophysics (USSR)(Engl. Transl.), No. 9: No. 2, 166-8(Oct. 1965).

Translated from Biofizika, 9: No. 2, 160-1(1964).

To evaluate the contribution made to the stability of the DNA molecule by the system of hydrogen bonds the method of replacing hydrogen by deuterium was used. It was concluded from previous studies that the effect of deuterium substitution might be seen in the curves of fusion of denatured DNA where the ordered structure of water is probably absent. However, the curves showed no change indicating that for the deuterium substitution the strength of the hydrogen bond in DNA showed virtually no change. No change was found in the temperature of the helix-coil transition on deuterium substitution in DNA. (M.C.G.)

15 RADIATION MEASUREMENT IN PHOTOBIOLOGY: CHOICE OF UNITS. Craig, R. E. (Marine Lab., Aberdeen, Scotland). Photochem. Photobiol., 3: 189-94(Sept. 1964).

Recommendations are made for adoption of the quantum as the unit of intensity and the electron volt as the specification of spectral quality, thus bringing the nomenclature of photometry into line with other branches of radiation physics. Definitions are given for some of the essential derived units, source intensity, irradiation, and flux. The quantum theory of interpretation of radiation is outlined. It is pointed out that in its interaction with matter, radiation behaves as if it were a stream of particles (quanta or photons). Each photon carries a definite amount of energy, and has a wave pattern associated with it in space. This wave pattern has a definite frequency, which is proportional to the energy, and a definite wavelength. The energy can be expressed in ergs, or in electron volts. For visible radiation, the photon energy is in the region of 1 to 2 ev. Thus, light consists of individual photons, each of which has resulted from a single electron having jumped from one energy state to another which is lower by about 1 or 2 v. It means also that one such photon is capable of dislodging an electron whose binding energy does not exceed 1 or 2 v. The photosensitive surfaces used in most radiation measurements are selected to have low binding energies, and it is not possible to find such surfaces with binding energies below 1 v. Thus both instrumental and biological detectors are limited by the same factor, that it is difficult to detect individual photons whose energy is below one ev. Below this photon energy, radiation is only detectable readily by its direct heating effect, and the sensitivity of reception falls off tremendously. (BBB)

16 ENDOTHELIAL PERMEABILITY—THE PASSAGE OF PARTICLES INTO AND OUT OF DIAPHRAGMATIC LYMPHATICS. Casley-Smith, John R. (Univ. of Adelaide). Quart. J. Exptl. Physiol., 49: 365-83(Oct. 1964).

The passage of particles (ThO_2, carbon, ferritin, lipoproteins, chylomicra) from the peritoneal cavities of mice into their diaphragmatic lymphatics, and from these vessels into the perilymphatic connective tissues was studied. The electron-opaque test particles were Indian ink (about 50 mμ diameter), purified ferritin (about 10 mμ diameter), thorium dioxide (Thorotrast, 10 to 30 mμ diameter), and washed chyle from the thoracic duct of olive oil-fed rats. The chyle contained both chylomicra (0.1 to 1μ diameter) and lipoproteins (10 to 100 mμ diameter). The particles were injected into the peritoneal cavities of 2-month-old mice. Gross differences were seen between the amounts of the various particles which traversed the endothelium by each of these routes. The routes also varied markedly in their importance. Open junctions were most important for the passage of all the particles from the peritoneal cavity although some of the particles used them relatively very little when they passed out of the lymphatics. The open junctions probably vary in size with the respiratory movements of the diaphragm. (TCO)

Ecology

Refer also to abstract 157.

17 SOME EFFECTS OF NEUTRON-GAMMA RADIATION ON LATE SUMMER BIRD POPULATIONS. Schnell, Jay H. (AEC Savannah River Plant, Aiken, S. C.). Auk, 81: 528-33(Oct. 1964).

Bird populations of a small valley 50 miles north of Atlanta, Georgia, were exposed to high level neutron-γ radiation which was released from a 10-Mw, air-shielded nuclear reactor. The reactor operated for five days in each of three consecutive weeks. Changes in numbers of birds living in the irradiated valley with those in a similar non-irradiated area were compared. Birds were censused on the two study areas, each about 3000 ft in diameter. Singing bird numbers declined at a greater rate in the irradiated area than in the control area. The singing Indigo Buntings (Passerina cyanea), Yellowthroats (Geothlypis trichas), and Bobwhites (Colinus virginianus) disappeared after the first week of irradiation. In the control area these species decreased in numbers but did not disappea.. Carolina Wrens (Thryothorus ludovicianus), Eastern Wood Pewees (Contopus virens), White-eyed Vireos (Vireo griseus), and Red-eyed Vireos (Vireo olivaceus) also disappeared from the irradiated area. The estimated total doses received by the disappearing birds ranged up to 20,000 rad. In contrast, the numbers of nonsinging individuals which were not occupying territories declined slightly in both areas, but no difference was detectable between irradiated and control areas. The results suggest a definite effect of radiation on the resident populations in the irradiated area. Undoubtedly some of the exposed singing birds were affected by radiation although no dead or sick birds were observed. It is likely that the movements of nonterritorial birds prevented large-scale deaths. Most birds probably did not remain near the reactor long enough to obtain a severe dose. Apparently, radiation affected the territorial birds adversely, but since no dead birds were found it could not be determined whether the disappearances were due to radiation mortality, reduction of the singing urge due to radiation sickness, or emigration as a result of radiation flux. (BBB)

18 CONSERVATION OF THE WATER RESOURCE: THE RESPONSIBILITY OF THE SCIENTIST. Commoner, Barry (Washington Univ., St. Louis). J. Water Pollution Control Federation, 37: 60-70(Jan. 1965).

Problems of water pollution, particularly by radioactive fallout and organic chemicals, are discussed. The program of the U. S. Public Health Service, beginning in 1957, of monitoring contamination of water and other substances is outlined. Introduction of ^{131}I radioactivity into the food chain is discussed. Evaluating the hazards of fallout in the biosphere and radiation exposure control measures are considered. (BBB)

19 CERIUM, IRON, AND MANGANESE SORPTION BY SOIL COLLOIDS AND UPTAKE BY PLANTS (thesis). Kampbell, Donald Henry. Columbia, Mo., Univ. of Missouri, 1964. 136p.

Investigations were made to determine the sorption of cerium, iron, and manganese in aqueous suspensions of some common soil colloids by isotopic equilibration with variable factors of acidity, ionic concentration, and chelating agents. All colloidal systems of kaolinite, illite, Putnam, and montmorillonite clays and fibrous peat had a high affinity for cerium. Only under very acid conditions did cerium remain in solution. Cerium was easily replaced from the colloids by hydrogen ions. The chelating agent DTPA was very effective in keeping trace amounts of cerium in solution. More iron than manganese was adsorbed by the colloids. At pH 4 the fibrous peat and illite had the highest affinity for manganese and iron, respectively. Twenty ppM levels of DTPA and EDTA were more effective than NTA in keeping manganese and iron in solution. Greenhouse studies were conducted to determine the influence of acidity, chelating agents, soil colloids, and nutrient solutions on the uptake of cerium, iron, and manganese by young corn plants. The uptake of trace ^{144}Ce was greatly reduced by the presence of any colloid. Uptake differences by equal rates of DTPA, EDDHA, CDTA, Fe-EDTA, and Na-citrate showed that DTPA was most effective in increasing ^{144}Ce uptake and that Na-citrate was least effective. Nutrient solution phosphorus increased cerium uptake while nitrogen had no detectable effect. A decrease of pH increased cerium uptake. A plant species difference in cerium uptake occurred with soybeans > peas > wheat > corn or legumes > grasses. Manganese and iron plant uptake studies were conducted with carrier applications of 3 ppM Mn and 3 ppM Fe both as sulfates. The presence of any colloid reduced manganese and iron uptake. In studies with nitrogen and phosphorus nutrient solutions only phosphorus increased iron uptake while manganese uptake was not effected. (A.G.W.)

Metabolism, Tissue Distribution, and Toxicology

20 (EUR–2451.e) BEHAVIOUR OF DNA SYNTHESIS IN DIFFERENT PHASES OF THE S-PERIOD IN CHROMOSOMES OF HUMAN ACUTE LEUKAEMIA. Gavosto, F.; Pegoraro, L.; Pileri, A.; Bernardelli, R. (Turin Univ. (Italy). Istituto di Clinica Medica Generale e Terapia Medica). 1965. 10p. (CONF-640805–2). Dep. mn.

From International Society of Hematology Congress, Stockholm.

A previously reported in vivo technique was improved in order to investigate the behavior of DNA synthesis at chromosome level in different stages of the S-period in human acute leukemia cells. After intravenous injection of tritiated thymidine (resulting in a pulse labeling), bone marrow samples were withdrawn at different intervals. The incorporation of thymidine was determined within the chromosomes and their segments of c-mitoses of cells which at the moment of labeling were in the early, intermediate, and final stage of the S-period. Comparative analysis of the incorporation values in the single chromosomes and in the different stages of the synthetic period was performed. Asynchronism of DNA synthesis was evaluated through the whole S-period, and it was shown to be more evident in the terminal stage as compared to the early phase. (auth)

21 (NYO–2598-25) LEACHING AND REDISTRIBUTION OF METABOLITES IN CUTTINGS PROPAGATED UNDER INTERMITTENT MIST [Thesis]. Good, George Lawrence (Cornell Univ., Ithaca, N. Y.). Feb. 1966. Contract AT(30-1)-2598. 84p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The extent of nutrient leaching from cuttings of common ornamental plants during rooting under mist was studied using radioisotopes as tracers. Results indicate that herbaceous, softwood, and semi-hardwood cuttings are difficult to leach. Nutrient deficiencies sometimes occurred in cuttings under mist through the leaching action of the mist and the diluting effects of the carbohydrates added as the cuttings grow. The use of nutrient mist proved beneficial in eliminating these nutrient deficiency symptoms when they occurred. (97 references.) (C.H.)

22 (NYO–3086-1, Pt.II) A COMPREHENSIVE SURVEY OF THE ^{226}Ra, ^{228}Ra, ^{228}Th AND ^{210}Pb CONTENT OF THE TISSUES OF A RADIUM DIAL PAINTER. Petrow, Henry G. (New York Univ., N. Y. Inst. of Environmental Medicine). 27p.

The ^{226}Ra, ^{210}Pb, ^{228}Ra, and ^{228}Th content in the bones of radium dial painters was determined for a large number of sites from eleven different bones. The data support a hypothesis that ^{210}Pb and ^{226}Ra are eliminated from bone at equal, or nearly equal rates, and that differences in the relative ^{210}Pb and ^{226}Ra concentration for the various bone samples are the result of differences in the fraction of radon that diffuses from the bone before it decays. There is strong negative correlation between the radium concentration at a given bone site and the concentration of ^{210}Pb. This indicates that the outgassing factor is greatest at sites having the highest radium concentration. There also appears to be a correlation between roentgenographic evidence of bone damage and radon loss rates. The observed disequilibrium between ^{210}Pb and ^{226}Ra can affect the dose to a particular bone site by as much as a factor of two. Radium-226 distribution was studied in the bones of a woman who was exposed as a radium dial painter for three years. Wide variations in ^{226}Ra burdens were found from bone to bone and in different areas of the same bone, the maximum variation within a single bone being in the radius. Disequilibrium was also noted with respect to the ratio of ^{228}Ra and ^{228}Th. (H.G.D.)

23 (NYO–3086-1, Pt.III) THE ^{228}Ra AND ^{228}Th DISTRIBUTION IN THE BONES OF A BEAGLE INJECTED WITH ^{228}Ra. Petrow, Henry G.; Cover, Arthur; Schiessle, Walter (New York Univ., N. Y. Inst. of Environmental Medicine). 12p.

Bone specimens were taken from a dog which had been injected seven years previously with ^{228}Ra. The bones were sectioned into small segments and analyzed for ^{228}Ra and ^{228}Th. While the average ^{228}Th to ^{228}Ra ratio found by radiochemical analysis confirmed the ratio found by whole body counting at Utah, the variation from sample to sample was also evident in the beagle bones. It is hypothesized that the variations are due to thorium translocation. The average thorium movement necessary to explain the deviations from the average ^{228}Th to ^{228}Ra ratio is about 9%. (TCO)

24 (RFP–640) PLUTONIUM EXCRETION FOLLOWING CONTAMINATED ACID BURNS AND PROMPT DTPA TREATMENTS. Lagerquist, C. R.; Allen, I. B.; Holman, K. L. (Rocky Flats Plant, Dow Chemical Co., Golden, Colo.). Sept. 8, 1965. Contract AT(29-1)-1106. 12p. (CONF-651008–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Annual Bio-Assay Meeting, Albuquerque, N. Mex.

DTPA (diethylenetriaminepentaacetic acid) treatments removed 99.5 percent of the plutonium from an individual who suffered a contaminated nitric acid burn. The DTPA treatments were given promptly and continued for 27 consecutive days. A total of 210,000 d/m of plutonium was eliminated in the urine in the first 60 days after the accident. This case is similar to an exposure which occurred a year previously. In both cases, a sum of two exponentials expresses the daily plutonium excretion in the urine over the first 60 days. (auth)

25 (TID–22294) PERCUTANEOUS TOXICITY STUDY OF STABLE RARE EARTHS IN RELATION TO INDUSTRIAL PROCESSING. [Progress] Report, January 1, 1964–April 30, 1965. (Pharmatox Labs., Inc., Ames, Iowa). Sept. 1, 1965. Contract AT(11-1)-1292. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Progress is reported on an experimental study conducted in laboratory animals to evaluate potential health hazards to workers exposed continually to rare earth metals in industry. Consideration is given particularly to the relationship of industrial solvents, coolants, and lubricants used in fabrication of rare earth metals into finished products. The rare earths studied are neodymium, dysprosium, and yttrium. The solvents used were: penetrating oil, trichloroethane, and motor oil. The three phases are: percutaneous studies in rabbits; mucous membrane contact studies in rabbits and dogs; and residue studies in tissues, urine, and feces. (TCO)

26 (TID–22322) SOME EFFECTS OF ACCUMULATED RADIUM ON THE PRODUCTIVITY OF ALGAE. Final Progress Report. Sigler, William F. (Utah State Univ., Logan). [nd]. Contract AT(11-1)-1023. 31p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Results are reported from an aquarium study of the effects of accumulated Ra on the productivity of two genera of benthic algae, Vaucheria and Cladophora, from the Logan River, Utah. River water, containing 5 different concentrations of ^{226}Ra, was used as the culture medium. At the end of selected time periods measurements were made of dry weight, nitrogen content, lipid content, Ra uptake, oxygen production, and ^{14}C uptake. Radium-226 was accumulated by all the algae tested, however, the amount of Ra taken up was affected by the genus of the algae, the concentration of Ra in the medium, and the length of time the algae was exposed to the Ra. It appeared likely that sorption played the most important role in the accumulation of Ra since there is no known metabolic requirement for it. Results demonstrated there were effects on the algae caused by exposure to Ra but it was impossible to distinguish between possible radiation or chemical effects. (C.H.)

27 INFLUENCE OF SOME DENTAL RESTORATIONS ON THE CONCENTRATIONS OF INORGANIC CONSTITUENTS OF THE TEETH. Soeremark, Rune (Univ. of Umea, Sweden); Ingels, Ove; Plett, Harry; Samsahl, Knut. Acta Odontol. Scand., 20: 215-24(1962).

The concentration of some trace elements in normal human enamel and dentin was studied in intact first perimolar teeth from 14- to 16-year-old boys and girls. The values were obtained by neutron activation analysis, with chemical group separation of the activated enamel and dentin, followed by γ-ray spectrometric analysis. For neutron activation, a flux of about 2×10^{12} neutrons cm^{-2} sec^{-1} for about 20 hr, was used. The teeth were also analyzed after having been restored with gold inlays, silver amalgam, and gold veneer crowns, or after having had gold or chromium-cobalt clasps in contact with their enamal surfaces for given periods of time. To determine if penetration of these metals into the tooth substance had occurred, the autoradiographic method using ^{198}Au in the clasps and restorations was conducted. The results of the studies in vitro as well as in vivo showed in enamel and dentin high concentrations of those elements present in the restorations or clasps applied to the teeth under study. In comparison with previous studies of the normal concentrations of inorganic constituents of intact enamel and dentin, a significant increase of the concentrations of Ag, Zn, Au, Co, Cr, Hg, and Pt was observed. The autoradiograms showed that ^{198}Au was taken up by the phosphate cement layer. A narrow diffuse black zone was also found in the autoradiograms corresponding to the dentinal walls of the cavity. This indicated an uptake of radiogold also in the dentin. Teeth which had gold clasps on their enamel surfaces for three weeks also showed autoradiographically a small uptake of radiogold in the areas of the enamel surface which had been in contact with the clasps. Neutron activation analysis of the whole enamel and of the coronal dentin showed a pronounced increase in the concentrations of those elements also present in the restorations and clasps. (BBB)

28 THE DETECTION OF INTESTINAL ABSORPTION OF ^{57}Co TAGGED VITAMIN B_{12} BY SERUM COUNTING. McCurdy, Paul R. (District of Columbia General Hospital, Washington, D. C.). Ann. Internal Med., 62: 97-102(Jan. 1965).

A serum radioassay method was developed to replace the Schilling test to measure ^{57}Co-labeled vitamin B_{12} utilization. There are several disadvantages of the standard Schilling urinary excretion test. The patient receives a large parenteral flushing dose of nonradioactive vitamin B_{12} that may constitute unwanted treatment. The test depends upon renal function and a complete urine collection, and a few cases are difficult to classify by this test. Plasma radioactivity reaches a maximum concentration 8 to 12 hr after the tagged vitamin B_{12} is administered orally. This corresponds to the time of greatest urinary excretion. The low energy γ radiation of ^{57}Co is counted with high efficiency by scintillation crystals. In the test described, after an overnight fast, 0.5 μg of vitamin B_{12} with 0.5 μC of ^{57}Co radioactivity was administered orally with about 50 ml of water. One half hour later, 1000 μg nonradioactive B_{12} was administered intramuscularly. Urine was collected for 24 hr, and blood samples were taken before and 8 to 12 hr after the oral dose of $^{57}Co-B_{12}$. Radioactivity was determined in 4-ml portions of the 24-hr urine and of the two serum samples using a well-type scintillation counter equipped with a single channel pulse height analyzer. The results of 101 tests in 83 patients showed that the detection of radioactivity in serum is as valid a measurement of the absorption of ^{57}Co-tagged vitamin B_{12} as the detection of activity flushed out in the urine. When done together, they serve as a check on each other. The serum test may be superior to the standard Schilling test when renal function is poor or when urine collection is unreliable. (BBB)

29 THE RETENTION OF AN ORAL DOSE OF RADIOACTIVE MANGANESE IN THE PULLET AND THE EFFECTS ON RETENTION OF THE INTAKE OF INACTIVE MANGANESE. Hill, R. (Royal Veterinary Coll., London). Brit. J. Nutr., 19: 171-6(1965).

Determinations were made of Mn retention in the laying pullet and of the effects on retention of (1) giving a low-Mn diet for 10 weeks or more and (2) varying the quantity of inactive Mn with the radioactive dose. Retention was very small in all treatments so that even if differences among treatments occurred, they were unlikely to be detected by the difference method. Therefore, treatment effects were sought in the quantities of Mn present in the liver and blood. The latter experiments used ^{52}Mn because it was evident from earlier observations with ^{54}Mn that, if reliable counts of blood were to be obtained, the dose of radioactive Mn had to be increased to about 100 μC and it was less expensive and less hazardous to give this dose of ^{52}Mn than of ^{54}Mn. Droppings collected from pullets fed on a high Mn diet contained 91.2% of an oral dose of ^{54}Mn in the first 24 hr and very small amounts in subsequent 24 hr collections. The mean percentage recovery of ^{54}Mn in the droppings and gut contents of laying pullets that had been fed on low- or high-Mn diets, given a dose of ^{52}Mn in solution with small or large amounts of inactive Mn, and killed 24 or 48 hr after dosing was 92%. There were no differences among treatments. The mean ^{52}Mn content of the liver was 0.60% of the dose. There was significantly more in the livers of birds fed on the low-Mn diet (0.85%) than in those of birds fed on the high-Mn diet (0.35%), but the difference caused by varying the concentration of Mn in the dose solution was not significant. The concentration of radioactive Mn in the blood, though always low relative to the dose, reached a maximum in most birds 6–8 hr after the dose. Treatment effects were similar to those for the liver. The low activity appearing in blood taken shortly after the isotope was given suggests that the absorption of Mn in the pullet was much lower than that of Ca, Fe, or Co in the chick. (BBB)

30 STOP-FLOW ANALYSIS AND EFFECTS OF OSMOTIC DIURESIS ON RENAL CLEARANCE OF ^{85}Sr AND ^{45}Ca IN THE DOG. Mazzuoli, G. F.; Cinotti, G. A.; Stirati, G.; Meredino, S. (Universita, Rome). Compt. Rend. Congr. Intern. Nephrol., Prague, 2nd, 1963, 698-702 (1964).

Stop-flow analysis and mannitol osmotic diuresis were used for studying tubular reabsorption of ^{45}Ca and ^{85}Sr, and to compare the renal transport mechanism for these two cations. Reabsorptive patterns of Sr and Ca were qualitatively equal. The urinary concentration of Sr is lowered in the distal tubule at a point along the nephron which is close to, but always about two or three samples (collected at three-min intervals) proximal to the Na minimum. The urine:plasma (U:P) ratios for Sr and Ca, (divided by U:P ratios for inulin to correct for water reabsorption) reached a distal low of 0.009 to 0.011 for Ca, and 0.038 to 0.052 for Sr. These findings indicate that the distal tubule can transport these cations against large concentration gradients and that Ca is reabsorbed preferentially over Sr at this site. In the proximal stop-flow urine samples, both Sr and Ca concentrations were lowered no more than during free flow. During osmotic mannitol diuresis, at urine flows of 0.40 to 1.5 ml/min, Sr clearance ranged from 0.68 to 1.90 ml/min, and Ca clearance from 0.13 to 0.34 ml/min for each kidney, with a ratio of Sr/Ca clearance of about 5 to 6. As urine flow increased, Sr clearance and Ca clearance increased together, but not in the same proportion, the ratio of Sr/Ca clearance decreasing. Calcium and Sr clearances increased even when glomerular filtration rate remained constant. Since plasma diffusible fractions of both cations decreased, the increase of Sr and Ca clearance was the result of a decreased reabsorption of the ions by the tubules. Tubular reabsorption of Ca and Sr is independent of the tubular reabsorption of water. During osmotic mannitol diuresis, the values for the tubular reabsorption of Sr and Ca were similar to that of Na. It is evident that Ca and Sr (and probably also Mg and Na) compete with each other for a common reabsorptive system in the renal tubule. On the assumption that the distal tubule only slightly modifies urine during osmotic mannitol diuresis, no gross quantitative distinction between transport of Sr and Ca in the proximal tubule is evident. However, since the differences between Ca and Sr clearances at the maximal urine flows could not be accounted for by differences in the plasma diffusible fraction of the two ions, it is presumed that Ca is preferentially reabsorbed in the proximal convoluted segment of the nephron, in addition to the distal tubule. (BBB)

31 REMOVAL OF ^{46}Sc IN MAN. Spencer, Herta; Rosoff, Betty (Veterans Administration Hospital, Hines, Ill.). Health Phys., 11: 1181-5(Nov. 1965).

The removal of ^{46}Sc was studied in man following the intravenous injection of a single tracer dose of ^{46}Sc administered as the weak chelate nitrilotriacetate, NTA. The chelating agents EDTA and DTPA were used as enhancing agents at 24 hr and on the sixth day following the injection of the ^{46}Sc tracer. Infusions of either of the two chelating agents resulted in increased excretion of ^{46}Sc in urine, but DTPA was more effective than EDTA. Also, the urinary ^{46}Sc excretion remained elevated after the discontinuation of the infusions of DTPA. (auth)

32 SHORT-TERM RETENTION OF ^{85}Sr AND ESTIMATION OF INITIAL ^{90}Sr BURDENS IN HUMANS. MacDonald, Norman S.; Figueroa, William G.; Urist, Marshall R. (Univ. of California, Los Angeles). Health Phys., 11: 1187-94(Nov. 1965). (UCLA-12-538).

Data on the short-term retention of ^{85}Sr in 23 human subjects are presented. Following a single intravenous injection, body burdens were measured in a total body counter facility at frequent intervals over periods ranging up to several months. Eleven subjects were on metabolic balance regimens in the hospital so that urines and stools were collected and assayed for ^{85}Sr and Ca. This group includes examples of the extremes of skeletal calcium metabolism including those with avid retention of Ca, normal or balanced cases, and those with large daily loss of endogenous Ca. The amounts of ^{85}Sr excreted soon after administration varied widely among individuals and reflected the state of Ca metabolism for each person. Retention could be expressed as a power function of time $R = at^b$, with values of the slope b ranging from -0.83 in cases of negative Ca balance to -0.12 in a case with large positive balance. Normals ranged -0.27 to -0.29. Repetitive monitoring of knee and tibia areas divulged no reliable correlation with total body retention. Methods for estimating human body burdens of ^{90}Sr from bioassay data were reviewed briefly. Applicable data on ^{85}Sr urinary excretion vs retention were collected, combined with the present series and evaluated for utility in estimating ^{90}Sr burdens from single urine measurements. They suggest that the initial body burden of ^{90}Sr following an acute contamination can be estimated with a standard deviation of about ±38% by multiplying the number of μC of ^{90}Sr found in all the urine collected during the seventh full day by 47. (auth)

33 TISSUE DISTRIBUTION AND EXCRETION OF ^{137}Cs IN THE GUINEA PIG AFTER ADMINISTRATION BY THREE DIFFERENT ROUTES. Stara, J. F. (Dept. of Health, Education, and Welfare, Cincinnati). Health Phys., 11: 1195-1202(Nov. 1965).

Data were obtained for the distribution-excretion pattern of ^{137}Cs in guinea pigs over a period of 100 days after administration by three different routes. Three groups of twenty guinea pigs were used. Solutions of cesium chloride containing ^{137}Cs as a tracer were administered to the animals by inhalation, by ingestion and by intraperitoneal injection. Urine and feces were collected daily until sacrifice, and the time–tissue distribution patterns were determined after death. All measurements were made by gamma counting with a NaI(Tl) detector. Since cesium chloride is extremely soluble, it was absorbed rapidly from the lungs, the digestive tract and the abdominal cavity. After the first day, the skeletal muscle had the largest concentration of ^{137}Cs. Its retention in muscle may be approximated by a single exponential function with an average biological half life of 10 days. Concentration in other tissues did not differ significantly from that in the muscle. The ^{137}Cs concentration in total excretion followed an exponential pattern with a rapidly and a slowly decreasing component. The average urine-to-feces ratio was 2.8. More than 95% was excreted within 32 days; at this time, approximately 65% of the remaining radioactivity was located in the skeletal muscle. A distribution and retention study of ^{137}Cs in bone tissue is in progress. (auth)

34 AUTORADIOGRAPHIC STUDY OF THE DISTRIBUTION OF ^{144}Ce IN BONE TISSUE OF THE RAT. Remy, J.; Nizza, P.; Pelser, A.; Aeberhardt, A. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Int. J. Radiat. Biol., 9: 349-59(1965). (In French).

The distribution of ^{144}Ce in the femur of rats after a single intravenous injection was studied by means of serial autoradiograms of thin sections of whole, undecalcified bone. The zones of initial deposition and the fixation of ^{144}Ce in bone tissues at a various times up to 275 days post-injection were determined. (C.H.)

35 THE BIOLOGICAL BEHAVIOR OF RADIOSTRONTIUM IN RATS IN THE COURSE OF LACTATION. Kollmer, W. E.; Kriegel, H. (Heiligenberg-Institut, Ger.). Int. J. Radiat. Biol., 9: 369-81(1965). (In German).

The metabolism of ^{90}Sr after a single injection was followed in lactating rats during the first 10 days and compared with that of virgin females. Strontium-90 excretion was enhanced during lactation. When ^{90}Sr was injected 10 days after parturition, the ^{90}Sr loss compared with that of virgin females was high during the first 48 hr, but the amount lost during the following 8 days was comparatively low. The amount of ^{90}Sr transferred to young when injected 10 days after parturition was 2.5 times that injected the first day after parturition. Histologic studies of bone during lactation showed a resorption of spongiosa in the metaphysis of tibia and femur. (C.H.)

36 COMPARISON OF THYROIDAL IODIDE ACCUMULATION AND THYROXINE SECRETION IN EUTHYROID SUBJECTS. Fisher, D. A.; Oddie, T. H. (Univ. of Arkansas Medical Center, Little Rock). J. Clin. Endocrinol. Metab., 24: 1143-54(Nov. 1964).

Fractional thyroidal and renal radioiodine clearance and renal ^{127}I excretion were measured in 152 euthyroid subjects. Thyroidal ^{127}I accumulation (A) was calculated with short-term thyroidal and extrathyroidal radioiodine clearance measurements substituted for 48-hr thyroidal radioiodine uptake. Appropriate corrections were included for diurnal variations in renal radioiodine clearance, lag time in urine collections, and losses of iodine in uncollected urine and in sweat and stools. Thyroxine-^{131}I degradation (H_4) was measured by whole-body counting techniques and compared with calculated thyroidal ^{127}I accumulation in 29 subjects on a mean calculated daily iodine intake of 387 μg. A significant negative correlation of thyroidal radioiodine uptake and renal iodine excretion was observed. (TCO)

37 RENAL TUBULAR REABSORPTION OF IODIDE AS COMPARED WITH CHLORIDE. Walser, Mackenzie; Rahill, W. Joseph (Johns Hopkins Univ., Baltimore). J. Clin. Invest., 44: 1370-81(Aug. 1965).

The hypothesis was examined that renal iodide reabsorption is chiefly passive, occurring in the same portions of the nephron as the reabsorption of chloride and other small monovalent anions, with the ratio of the permeability of the tubule to iodide to its permeability to chloride a constant. If this were true, iodide clearance and chloride clearance would be interrelated in a uniform manner, and it should be possible to predict iodide clearance from chloride clearance. Dogs were given priming doses and a constant infusion of inulin and radioiodide ^{131}I, carrier-free. Carrier-free radiobromide was also given in some experiments; ^{131}I was determined in these instances after ^{82}Br had decayed to negligible levels. Simultaneous clearances of inulin, chloride, and ^{131}I, during constant infusion of ^{131}I, were measured in dogs salt depleted or infused with solutions of glucose, mannitol, NaCl, Na_2SO_4, $NaHCO_3$, HCl, NaI, NaBr, NaSCN, $NaNO_3$, $NaClO_4$, or combinations of these. If iodide and chloride are passively and coextensively reabsorbed, with the ratio of the tubular permeabilities to the two ions unchanging along the length of the tubule, log (excreted/filtered I)/log (excreted/filtered Cl) = k should be nearly constant. The calculated discrimination factor k was independent of plasma chloride or iodide levels, filtration rate, or the administration of these infusions. Increasing flow decreased k, indicating that iodide clearance varies slightly with flow independently of chloride clearance. For all experiments, $k = 0.468 - 0.7$ (flow/glomerular filtration rate). In individual experiments,

values of iodide clearance predicted in this manner from chloride clearance and urine flow were closely correlated with observed iodide clearance. These results are thus consistent with the hypothesis as stated above. However, at very low excretion fractions of chloride (<0.002), active transport of iodide became apparent, and iodide reabsorption in some instances was more nearly complete than chloride reabsorption. (BBB)

38 THE BEHAVIOR IN LUNGS OF THE RADIOACTIVE FLUORINE CERIUM ($^{144}CeF_3$) WITH ITS INTRATRACHEAL INTRODUCTION. Ivanov, A. E.; Gorelchik, K. I. Med. Radiol., 10: No. 7, 65-9(July 1965). (In Russian).

The behavior of fluorine cerium-144 in the lungs of rabbits, after its intratracheal administration, was studied by using scanning, radiometric, auto- and histoautographic methods of investigation. Factors governing the redistribution and elimination of cerium-144 from the lungs are educed, proving the presence of two periods in the diminution of the activity and a gradual concentration of the emitter within a restricted volume of the pulmonary tissue. (tr-auth)

39 INFLUENCE OF HEAVY WATER (DEUTERIUM OXIDE) ON PLAQUE SIZE OF WESTERN EQUINE ENCEPHALITIS VIRUS. Carp, Richard I.; Kritchevsky, David (Wistar Inst. of Anatomy and Biology, Philadelphia). Nature, 208: 93(Oct. 2, 1965).

The effects of 25% D_2O on the replication of two mutants of western equine encephalitis virus were studied. The results of two experiments showed that in every case plaque size was smaller in the D_2O medium. The observed differences were highly significant ($P < 0.001$). The data indicate that the nucleic acid moiety of a virus does not necessarily determine the nature of the viral growth response in D_2O. (P.C.H.)

40 SKIN CONTAMINATION BY RADIOACTIVE ISOTOPES. III. PIG SKIN CONTAMINATION BY ^{137}Cs, ^{60}Co AND ^{131}I. Wadachi, Yoshiki; Tashiro, Shingo; Inoue, Yoshinori; Muramatsu, Mitsuo (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 7: 492-5(Sept. 1965). (In Japanese).

Experiments were carried out to determine the surface and interior contaminations in layers of fresh pig skin that were soiled with ^{137}Cs, ^{60}Co, and ^{131}I solutions of various acidities and for various periods of soiling time. It was observed that the surface contamination by acidic ^{60}Co solution does not depend to any appreciable extent on the location of skin specimen or on the type of anion of the acid in the contaminant solution. An alkaline medium was found to increase surface contamination by cationic contaminant and to decrease that by anionic. It was found that the interior contamination is almost negligible, regardless of either the contaminant species or acidity, or of soiling time. (auth)

41 BIOLOGICAL ELIMINATION OF RADIONUCLIDES. Crossley, D. A. Jr. Nucl. Safety, 5: No. 3, 265-7(Spring 1964).

A review of information is presented on measurement and description of nuclide elimination rates, comparative elimination of radionuclides, and application of radionuclide elimination data in environmental studies. (J.R.D.)

42 THE ^{228}Th DECAY SERIES IN ADULT BEAGLES: ^{224}Ra, ^{212}Pb, AND ^{212}Bi IN BLOOD AND EXCETRA. Stover, Betsy J.; Atherton, David R.; Buster, Dawn S.; Keller, Nancy (Univ. of Utah, Salt Lake City). Radiat. Res., 26: 226-43(Oct. 1965).

Measurements of ^{224}Ra excretion, ^{224}Ra plasma concentration, and ^{212}Pb blood cell concentration were made through 3.5 years after injection of ^{228}Th into young adult beagles. Less extensive studies of urinary excretion of ^{212}Pb and ^{212}Bi, and of ^{212}Bi in blood plasma and cells, were also done. Initially ^{224}Ra in plasma decreased more rapidly than ^{228}Th in plasma. ^{212}Pb was associated with blood cells in relatively high concentration. Later the concentrations of ^{224}Ra in plasma and ^{212}Pb in cells were, respectively, 24 and 480 times that of ^{228}Th in plasma. ^{212}Bi in plasma was about twice ^{224}Ra, and in cells it was about 0.9 ^{212}Pb. At 30 days cumulative excretion of ^{224}Ra was 35%, compared with 11% for ^{228}Th. Of the ^{224}Ra atoms formed in vivo, 27% were excreted. The ^{224}Ra excretion rate decreased with time, and, at 100 and 1000 days, respectively, 12 and 7% of the atoms formed in vivo were excreted. The fecal excretion rate was greater than and decreased more slowly than the urinary rate. At 777 days cumulative urinary excretion of ^{212}Pb was 0.4%, which was about 0.6% of the ^{212}Pb atoms formed in vivo. Cumulative urinary excretion of ^{212}Bi ranged from 0.45 to 0.91%. Excretion of ^{224}Ra, ^{212}Pb, and ^{212}Bi formed in vivo does not substantially reduce the potential α-irradiation from ^{228}Th. Movement of these nuclides within the dog probably results in the irradiation of many more cells than if they decayed at the sites where ^{228}Th decays. (auth)

43 THE EFFECT OF NITROGEN MUSTARD POISONING ON THE SERUM PROTEINS. David, G.; Fiam, B. (Health Service of the Hungarian Peoples Army, Budapest). Radiobiol. Radiotherap., 5: 699-702(1964). (In German).

Nitrogen mustard (tris-β-trichloroethylamine) was administered intravenously to rabbits, cats, and rats at dosages of 2.5, 1.0, and 1.7 mg/kg, respectively. As control animals, rabbits were exposed to 1000 R of whole-body x irradiation. Serum from the animals was studied by agar electrophoresis and paper electrophoresis over a period of 6 days following treatment. In serum from the rabbits treated with nitrogen mustard the albumin concentrations were increased, the α-globulin was decreased, the β-globulin was slightly decreased, and the γ-globulin was decreased. In serum from cats treated with nitrogen mustard the albumin concentrations were decreased slightly, the α-globulin and the β-globulin concentrations were increased, and the concentrations of γ-globulin increased. In the rats treated with nitrogen mustard the serum albumin concentrations were decreased slightly and the α-globulin was increased. The β-globulin and γ-globulin concentrations increased initially but decreased almost to normal by the sixth posttreatment day. In the serum of the irradiated rabbits the concentrations of all of the proteins studied decreased. Immunoelectrophoretically, when the serum of rabbits immunized with rat serum or the α and β fraction of rat serum albumin was studied 24 hr after nitrogen mustard poisoning, the intensity of precipitates of the prealbumin (ϕ, $-\phi_2$), α_2-globulin, and the β-globulin were increased. The number of β_1 fractions increased and a new β_2 fraction appeared. No alteration of the γ-globulin and albumin was observed. The α_2-lipoproteins were not altered. After 48 hr the contents of the prealbumin, α_2, β_1, and β_2 fractions increased. The α_2-globulin zones and the 2 α_2-lipoprotein zones were almost blended together. The previously observed β_2 fraction had disappeared. Apparently the newly observed β_2 fractions and the blending of the α_2-globulins and lipoproteins were the result of the modifying effect of nitrogen mustard on protein molecules. (BBB)

Radiation Effects on Biochemicals

Refer also to abstract 394.

44 (COO-1148-98) PROSPECTS IN THE APPLICATION OF POLAROGRAPHY TO BIOLOGICAL PROBLEMS. Elving, Philip J. (Michigan Univ., Ann Arbor. Dept. of Chemistry). July 5, 1965. Contract AT(11-1)-1148. 44p. (CONF-650556-2). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Symposium on Electrical Methods and Principles in Molecular Biology, Jena, Ger.

The study of biologically important compounds and phenomena by means of polarography with the dropping mercury electrode and derived techniques such as oscillographic and alternating current polarography is discussed. Three areas of application considered include analysis, argument by correlation, and argument by analogy. These

areas are critically evaluated and it is postulated that these will constitute the most fruitful areas of future applicability of polarography to biological problems. An attempt was also made to evaluate the relative merits of polarography as compared to spectrophotometry in respect to potential utility in each of these areas. (C.H.)

45 (EUR-2471.f) INTERACTIONS DES RADIATIONS ET DES ACIDES DESOXYRIBONUCLEIQUES. (DEUXIEME ANNEE D'ETUDE). (Interaction of Radiation with Deoxyribonucleic Acids. (Second Year of Study)). Latarjet, R. (Institut Pasteur, Paris (France)). 1965. 6p. Dep. mn.

The effects of x and gamma rays on polynucleotides (U, C, A) were studied in the presence and absence of oxygen; the quantum yields were measured in respect to the destruction of the bases and of the breaking of the phosphodiester chains. The consequences to the coding activity in the Niremberg system were measured. These ionizing-radiation effects were compared with those of nitrogen mustard. Lastly, the part played by free radicals in these reactions was partially defined by electronic paramagnetic resonance measurements. The studies were extended to cover the effects of x rays on Pneumococcus-transforming DNA, where a "marker rescue" phenomenon was discovered, and on DNA exchanges between growing bacteria, and, lastly, on the bacterium bacteriophage system in lysogenic bacteria. Research went forward on radioactive disintegration effects on DNA constituents (thymidine) and on certain cellular nucleic acids; in particular, the induction of a mutation aimed at radiation resistance in yeast under the effect of ^{32}P disintegrations was analysed in biochemical and genetic terms. This radiation resistance is associated with the existence of abnormal meiosis. In conclusion, the progress of the studies of radiation effects on bacterial genetic recombination is described. (auth)

46 (PRNC-40) RESONANCE IN RADIATION EFFECTS. Technical Report No. 2. Luse, Robert A.; Vazquez Martinez, Florencio; Koo, Frank S.; Santiago de Morales, Rosa J.; Cruz Vidal, Baltasar (Puerto Rico Nuclear Center, Mayaguez). May 1964. Contract AT(40-1)-1833. 42p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

A research program is being conducted on the x-ray effects on biological systems in the 5-20 kev energy range which contains the K-absorption edges of constituent atoms. Solutions of carboxypeptidase A were irradiated with collimated x-ray beams at 7.6, 8.68, and 9.69 kev; preliminary inactivation curves are given. Studies are being made on the x-ray-induced production of F centers at room temperature in alkali halide crystals, and some preliminary results for KBr are described. Chromosomes labeled with 5-bromodeoxyuridine in onion root tips (Allium cepa) were irradiated by x rays at energies near the K-absorption edges of Br, and chromosomal breakages per cell are given. The development of high-intensity field-emission x-ray sources is described. Other equipment are discussed: x-ray spectrometer, low-temperature irradiation chamber, and devices for F-center measurement. (D.L.C.)

47 RADIATION-INDUCED OPTICAL INVERSION OF L-GLUTAMATE RESIDUES IN POLY-α, L-GLUTAMIC ACID. Southern, E. M.; Rhodes, D. N. (Meat Research Inst., Cambridge Eng.). Biochem. J., 97: 14c-16c(Oct. 1965).

When poly-α, L-glutamic acid was irradiated in aqueous 1% (wt/v) solution at pH 6.8, a major effect was the inversion of L-glutamate residues to the D-form. It is suggested that the first step in the observed inversion of glutamate residues is removal of the α-hydrogen atom to give a free radical, which, since it has a planar configuration, would be expected to give either D- or L-glutamate on recombination with hydrogen. (P.C.H.)

48 THE EFFECT OF ULTRAVIOLET IRRADIATION ON SOLUBLE COLLAGEN. Cooper, D. R.; Davidson, R. J. (Rhodes Univ., Grahamstown, South Africa). Biochem. J., 97: 139-47(Oct. 1965).

The effect of ultraviolet irradiation on acid-soluble and neutral-salt-soluble calf-skin collagen was studied by chromatography, gel filtration, amino acid analysis, and sedimentation of the sub-units, and the reaction kinetics of degradation were obtained from viscosity and optical rotation measurements. It was demonstrated that, whereas the structure of neutral-salt-soluble calf-skin collagen may be represented by the formula $(\alpha_1)_2\alpha_2$, the acid-soluble extract has the formula $\alpha_1\cdot(\alpha_2)_2$. The acid-soluble collagen is also unusual in containing a large amount of a component that could be β_{22}. Ultraviolet irradiation causes the progressive degradation of the collagen molecule into smaller molecular fragments that subsequently lose their helical nature. The rate constants show that the denaturation of soluble collagens by ultraviolet irradiation is much slower, under the conditions used, than denaturation by heat or enzymes. (auth)

49 EFFECT OF INORGANIC IONS ON THE CHANGES OF PROTEIN SOLUTION BY X-RAY IRRADIATION. Ueno, Y. (Kyoto Univ., Japan). Collect. Czech. Chem. Commun., 30: 2839-40(Aug. 1965).

Aqueous solutions of proteins were irradiated with x rays at room temperature with additions of NaCl, NaI, KCl, $CaCl_2$, and $MgCl_2$. The increase of the height of Brdička catalytic wave of proteins after x-irradiation in some ranges of radiation doses was verified. This increase was less marked in the presence of added inorganic salts. (M.C.G.)

50 STUDIES ON THE NUTRITIONAL VALUE OF FOODS TREATED WITH γ-RADIATION. II. EFFECTS ON THE PROTEIN IN SOME ANIMAL FEEDS, EGG AND WHEAT. Kennedy, T. S. (Wantage Research Lab., Eng.). J. Sci. Food Agr., 16: 433-7(Aug. 1965).

The effect of γ-radiation on the protein nutritive value of certain animal feeds (protein concentrates), frozen whole egg, whole wheat, and wheat gluten was measured by use of a microbiological method. There was little change in nutritive value of the animal feeds with doses of 0.5 and 1.0 Mrad and no change with frozen egg at 0.5 and 5.0 Mrad. Whole wheat showed no loss at 0.2 Mrad; a 6% loss at 1.0 Mrad was not increased further at 5.0 Mrad. Gluten prepared from wheat and then irradiated was unchanged at 0.02 Mrad, but losses of 5, 7, and 26% were shown with doses of 0.2, 1.0, and 5.0 Mrad respectively. Following amino acid supplementation studies and microbiological assays for methionine, loss of availability of this amino acid was demonstrated to be principally responsible for the lowering of the nutritive value of the 5.0-Mrad-irradiated wheat gluten. (auth)

51 THE INACTIVATION OF ENZYMES BY ULTRAVIOLET LIGHT. V. THE DISRUPTION OF SPECIFIC CYSTINES IN RIBONUCLEASE. Grist, Ken L. (Brookhaven National Lab., Upton, N. Y.); Taylor, Thomas; Augenstein, Leroy. Radiat. Res., 26: 198-210(Oct. 1965). (BNL-8679).

Titrations with p-chloromercuribenzoate (pCMB) or ^{14}C-iodoacetic acid (^{14}C-IAA) showed a direct correlation between the increase in titrable SH groups and destruction of ribonuclease (RNase) activity by 2537-A light: there was an increase of about 2.0 SH groups per molecule inactivated. A similar behavior was reported for trypsin; however, unlike trypsin, the residual enzymatic activity measured in irradiated RNase was not affected significantly by pCMB or urea added prior to assay. Autoradiographs of fragmented RNase reacted with ^{14}C-IAA showed that one or at most two specific cystines were disrupted by ultraviolet doses sufficient to destroy 50% of the enzymatic activity. Determinations of the ^{14}C associated with different fragments indicated that the various cystines were disrupted at quite different rates. The results seem consistent with a previous hypothesis that inactivation is initiated by the disruption of a specific cluster of secondary and tertiary bonds and inconsistent with the notion that ultraviolet inactivation depends on random destruction of amino acid residues. (auth)

52 LOCALIZED GAMMA IRRADIATION FROM ^{60}Co ON SYNTHESIS OF COLLAGEN BY SUBCUTANEOUS

GRANULOMAS. Nimni, M. E.; Gerth, Nancy; Bavetta, L. A. (Univ. of Southern California, Los Angeles). Radiat. Res., 26: 221-5(Oct. 1965).

Subcutaneous granulomas were caused by implanting polyvinyl sponges in the dorsum of rats. This area was subjected to γ irradiation from sealed sources containing 55 and 180 μC of ^{60}Co which were embedded inside the sponge prior to implantation. These levels of radiation, when maintained during 21 days, caused a decrease in the amount of soluble collagens present in the granuloma. Shorter exposures (6 and 13 days) did not seem to affect the metabolism of collagen. Skin areas proximal to the radiation source also showed a decrease in the rate of collagen synthesis. (auth)

53 GAMMA IRRADIATION EFFECTS ON SOLID RIBONUCLEASE. Friedberg, Felix; Hayden, George A. (Howard Univ., Washington, D. C.). Radiat. Res., 26: 263-8(Oct. 1965).

There were definite indications for structural unfolding of the ribonuclease molecule on γ irradiation in the solid state (increase in viscosity and increase in negative optical rotation), concomitant with the loss in enzymatic activity. Disulfide interchange did not occur to any appreciable extent. The data establish that the number average molecular weight of the enzyme is not changed by the irradiation. (auth)

54 THE REDUCTION OF n-PROPYLHYDROPEROXIDE BY SERUM AND ORGANIC FILTRATES OF NORMAL AND IRRADIATED RATS. Wagner, H.; Pradel, I. (Humboldt-Universitaet, Berlin). Radiobiol. Radiotherap. 6: 459-66(1965). (In German).

The reduction of n-propylhydroperoxide in rats by filtrates from liver, testes, and muscle was not significantly affected by irradiation. However, a change in the reducing capacity of serum was found and was shown to be dependent on dose and time. A parallel increase in oxidizing substances appeared after 800 R doses. (H.G.D.)

Radiation Effects on Tissues

Refer also to abstract 46.

55 (EUR-2469.f) LES CELLULES IMMUNOLOGIQUEMENT COMPETENTES. (Immunologically Competent Cells). Mathe, G.; Amiel, J. L.; Brezin, C.; Choquet, C. (Association Claude Bernard, Paris (France)). 1965. 19p. Dep. mn.

The part played by the number of immunologically competent cells in the nature of the response to a given antigen was studied. It was shown that in the irradiated adult animal the ability to respond to an antigenetic stimulus following irradiation depends upon the number of lymphoid cells contributed by the graft. Immunization against a heterologous protein is nil if the graft is less than 10^5 cells, but normal if it is at least 2.5×10^7 cells. However, a graft of 2.5×10^7 ganglionic cells does not cause immunization of an irradiated host if it comes from previously irradiated donors who had received 10^5 ganglionic cells or less and been subjected immediately after irradiation to the same antigenic stimulus. The induction of an inbalance in the proportion of antigenic stimulus to the number of immunologically competent cells, by a sufficient reduction of the denominator thus produces cell levels in an adult organism, lasting transmissible grafts, and specific modifications. A comparison was made of the immunological competence of lymphoid cells of various origins. The test used was the reaction of the graft against the host. It was shown that the injection into irradiated recipients of semi-allogenic peritoneal macrophages, which in themselves are inactive, considerably reinforces the immunizing reaction of a graft of semi-allogenic thymic cells against the host. (TCO)

56 (NASA-SP-7011(15)) AEROSPACE MEDICINE AND BIOLOGY. A Continuing Bibliography with Indexes. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.). Sept. 1965. 154p. CFSTI $1.00 cy, $1.00 mn.

Approximately 500 annotated references to unclassified reports and journal articles introduced in the NASA Information System during Aug. 1965 are presented. The subject coverage includes biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the earth's atmosphere or in interplanetary space. Corporate source, subject, and author indexes are included. (C.H.)

57 (NYO-901-37, pp 7-13) BIOLOGICAL CHEMISTRY. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.).

A brief summary is presented of results of studies of adaptive changes in enzymes in animals under the influence of various physiological conditions, hormones, substrates, cancer, or radiation. A growth model was developed to predict the growth rate of tumors and the effects of therapy. Adaptive enzyme changes involved in the etiology of phenylketonuria, an inborn metabolic disease resulting in mental deficiency when not diagnosed and treated, were established. Studies were also conducted on the adaptive behavior of tryptophan pyrrolase and tyrosine transaminase in liver under the influence of various physiological conditions, hormones, substrates, and actinomycin; and the role of ascorbic acid in tyrosine metabolism in scorbutic guinea pigs. Results of these studies led to the conclusion that the action of many hormones is exerted by alteration of the concentration of specific enzymes. (C.H.)

58 (NYO-901-37, pp 14-30) BIOPHYSICS AND RADIATION PROTECTION. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.).

Topics discussed include the development of procedures of postmortem examination of radioactive cadavers; the development of a method for irradiating single cancer cells growing in tissue cultures using a ^{91}Y radiation source; the effects of ^{60}Co pellets when implanted in various sites in mice; the design and fabrication of various accessories and adaptors for use in x-ray diffraction studies; the effects of age and humidity on ring tail in young rats; the development of air conditioned, gas-tight housing for animals used in $^{14}CO_2$ inhalation experiments; the development of facilities for the exposure of animals, cells, or tissues to x radiation at energies of 40 to 2,000 kvp; and the development of data recording systems for use in radiobiological studies. (C.H.)

59 (NYO-901-37, pp 31-2) BIOSTATISTICS AND ADMINISTRATION. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.).

Preliminary data are presented from a survey of the radiation exposure, health, and fertility of over 2,000 dentists. Data on the cause of death of 186 dentists indicate an apparently low incidence of malignancies in this group. (C.H.)

60 (NYO-901-37, pp 33-68) EXPERIMENTAL PATHOLOGY. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.).

Preliminary results of an investigation of incidence of leukemia in patients with cancer of the cervix treated with radiotherapy revealed 14 instances of hematologic disorders, including 3 cases of leukemia, in 24,000 patients. The incidence of leukemia is in line with the incidence expected in an unselected population. Results are reported from a study of bone pathology and bone tumor incidence in mice injected with ^{239}Pu and treated with diethylenetriaminepentaacetic acid (DTPA). A significant increase in survival and reduction of malignant bone tumors followed treatment with DTPA for 8 to 12 days after ^{239}Pu injection. Data are included from histopathologic studies of changes of bones in patients with radium poisoning conducted on biopsy and autopsy material and chromosome studies on patients with radium or thorium poisoning. The burdens of Ra and Th ranged from less than 0.1 μC to 1.96 μC with a time lapse of 13 to 49 years since the last exposure. Chromosome analysis of peripheral blood cells in tissue culture showed numerous structural aberrations. There

seemed to be a relation between the number of cells showing chromosome aberrations and body burden. Chromosome aberrations observed in 3 cases of accidental exposure to radiation are described. Data are summarized from a series of studies on the etiology, pathogenesis, surgical treatment, and radiotherapy of cancer in man and experimental animals and studies on tumor cells in culture. Emphasis was placed on carcinoma of the bladder, metastases of carcinoma of the cervix, breast cancer prognostic signs, host response by organ systems not directly involved by cancer, and the radiosensitivity of 5 human tumors carried in the hamster cheek pouch. Data are included on the carcinogenic effects of ^{60}Co wires embedded in the lungs of mice, rats, hamsters, guinea pigs, and rabbits; the effects of x radiation of doses as low as 60R on embryonic development and the central nervous system in rat embryos; the induction of breast cancer in female rats with intragastric or intravenous doses of 7,12-dimethylbenzanthracene; the pathologic effects of intermittent x radiation exposure on mice; and the development of a 22-generation inbred colony of albino rats for use in experimental studies. (C.H.)

61 (NYO–901-37, pp 69-73) HEMATOLOGY. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.).

Hematologic studies are outlined. Emphasis was placed on studies of the reticuloendothelial system as illustrated by macrophages and monocytes and the part played by reticuloendothelial cells in lipid and cholesterol metabolism; serum albumin and its effects on blood and tissue cells; and studies of lymphoid and plasma cells. Factors affecting the radiosensitivity of hematopoietic cells were also studied. (C.H.)

62 (NYO–901-37, pp 74-9) RADIOBIOLOGY. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.).

A fluid emulsion technique developed for autography gave good results using many isotopes in a variety of labeled compounds, particularly those labled with carbon and tritium. Results are summarized from a series of experiments on the physiologic and pathologic effects of relatively low doses of ^{131}I on mouse thyroid. The data indicates a clear-cut morphological response to ^{131}I in the retained dose range from 1 to 9 μC, or approximately 10 to 90 rad. (21 references.) (C.H.)

63 (STI/DOC/10/42, pp 45-55) RADIATION BIOLOGY. (International Atomic Energy Agency, Vienna (Austria)).

Work done under four research contracts is summarized: study of primary and intermediate products of gamma radiation on aqueous solutions by absorption spectroscopy, necrolytic and radiolytic lesions at mitochondrial level (lysosomes) in aseptic perfused beef heart muscle, immediate effect of irradiation on fatty-acid metabolism, and relative radiosensitivities of molds and their pectic enzymes. (D.L.C.)

64 (SZS-5(1965)) I. REAKTION DES BLUTBILDES UNTER DER EINWIRKUNG IONISIERENDER STRAHLEN, BESONDERS IN HINBLICK AUF DIE VERAENDERUNGEN DER MORPHOLOGISCHEN ELEMENTE UND DER BLUTEIWEISSKOERPER. II. KOMBINIERTE SCHAEDIGUNGEN DURCH ENERGIEREICHE STRAHLUNG UND IHRE BEHANDLUNG. (I. Reaction of Blood Formers Under the Influence of Ionizing Radiation, Especially in Consideration of the Change of Morphological Elements and the White Corpuscles. II. Combined Damage from Energetic Radiation and its Treatment). Morczek, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). July 1965. 40p. Dep. mn.

Among the criteria of radiation injury, the hematologic alterations are of most importance. The consequences of radiation influence may appear in different ways. Hematologic single findings are not significant for diagnosis but for following the reaction course. Most important criterions of radiation exposure are diminution of the total leukocytes after initial increase, decrease of the lymphocytes and thrombocytes as well as deviation to the left within the polymorphonuclear leukocytes. Besides numerical alterations, morphologic studies of the blood cells may give further information, however, they will not be sufficiently reliable because of their low constancy. An attempt was made to grade the individual criterions in view of the calculation of their variability coefficients in normal blood counts and in blood counts of persons exposed to radiation. Investigations of protein fractions in serum give, within the dose range of interest, no information about radiation exposure in case of external radiation. Within the dose level of occupational radiation exposure, no hematologic alterations are expected. The hematologic criteria are always to be judged in connection with the result of the clinical examination. (tr-auth)

65 (TID–22174) THE OCCURRENCE OF CHROMOSOMAL ABERRATIONS IN PRE-SPERMATOCYTIC CELLS OF IRRADIATED MALE MICE. Final Report, January 1, 1958–May 31, 1965. Griffen, Allen B. (Roscoe B. Jackson Memorial Lab., Bar Harbor, Maine). Contract AT(30-1)-2113. 15p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Experiments were performed to determine the extent to which chromosomal aberrations of major proportions, especially translocations, are produced in irradiated spermatogonial cells of the mouse. Male mice bearing the marker Bent-tail, a sex-linked gene, were given 350 or 700 R doses of x rays. During irradiation the animals were shielded with 2mm lead except for the region of the testes. Following irradiation each male was mated with three C57BL/6J females. All F_1 females surviving to weaning age were mated individually to C57BL/6J males. Sterile (S) and semi-sterile (SS) offspring of the irradiated males were scored. The S and SS profiles revealed by the 350 R and 700 R composites were in general quite similar and showed that aberrant offspring were produced throughout the life of the irradiated males. It was concluded that multiple appearances and reappearances of translocations in mature spermatozoa are due to nuclear changes induced in spermatogonia by irradiation. However, no cytological evidence was obtained that might indicate the repeated appearance of a particular aberration; each translocation studied must be judged to be morphologically unique rather than a member of a recognizable specific class or cluster. (H.G.D.)

66 (TID–22292) TUMOR INDUCTION IN MICE BY RADIOACTIVE THYMIDINE. Baserga, Renato; Lisco, Hermann; Kisieleski, Walter E. (Northwestern Univ., Chicago, Ill. Dept. of Pathology; Argonne National Lab., Ill.). [1965]. Contract AT(11-1)-1131. 48p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Thymidine, a desoxynucleoside that is exclusively incorporated into nuclei of cells synthesizing DNA in preparation for cell division, was injected into CxA F_1 mice of different ages. When labeled with either ^{3}H or ^{14}C, thymidine increased the incidence of tumors and shortened the life span of CxA F_1 mice. The incidence of rare tumors was particularly increased, while tumors that are relatively frequent in this breed of mice, such as lung tumors and lymphomas, showed a shorter induction time. The life-shortening and carcinogenic effects of radioactive thymidine was more evident at high doses (about 10 μc per gr of body weight with ^{3}H thymidine), and in mice injected as newborn than in mice injected in adult life. Retention studies showed that radioactivity injected in newborn mice could still be detected in DNA of several tissues three years later. The results indicate that the carcinogenic action of tritiated thymidine can be ascribed to its radiation effect on the nuclei of cells. (30 references.) (auth)

67 EFFECTS OF RADIATION ON PROTEINS. VI. INFLUENCE OF γ RAYS ON CRYSTALLIN PROTEINS. Buruiana, L. M.; Pavlu, V. (Facultatea de Medicina Veterinara, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Biochim., 5: 365-75(1962). (In Rumanian).

Discussion of the possible relations between the structures of proteins and their polarographic behavior is given;

polarographic analysis is determined to be a useful means for investigating several aspects of the structure of proteins. This method was used to study the behavior of lens proteins (crystallins α, β, and γ) on irradiation with γ rays of low intensity (0.03 R/hr). Data are presented for the effect of radiation of up to 24 hr duration on solutions ranging from 3 to 33 mg%. The effect of irradiation depends on the solution with which the extraction of the protein is performed. The fractions extracted with distilled water are more sensitive to irradiation; those extracted with physiological solution (0.9% NaCl) are less sensitive. It is concluded that extraction of crystallin with distilled water produces a denaturation of the proteins. The nature of the effect of distilled water is discussed very briefly. (BBB)

68 DEGENERATION AND REGENERATION OF MYELINATED FIBERS IN THE CEREBRAL AND CEREBELLAR CORTEX FOLLOWING DAMAGE FROM IONIZING PARTICLE RADIATION. Estable-Puig, Juan F.; De Estable, Rosita F.; Tobias, Cornelius; Haymaker, Webb (Armed Forces Inst. of Pathology, Washington, D. C.). Acta Neuropathol., 4: 175-90(1964).

Long-Evans rats, 3 weeks of age, were exposed to 48 Mev α particles from the 60-in. cyclotron in Berkeley. The brain-surface dose was 6000 rad, and in Bragg peak, the dose was 30,000 rad. The average dose rate was 1000 rad/min to the brain surface, or about 10^8 particles/cm^2-sec. After exposure, the animals were sacrificed at 4 hr to 7 months, and the brains were fixed for electron microscopy. An initial change following exposure to 6000 rad consisted in damage of occasional nerve cells in much of the irradiated cerebral cortex, but particularly in the region of maximal penetration of the particles, which was about 1 mm deep to the brain surface. The similar changes occurred in the cerebellar granular layer, though many more granule cells were pyknotic. By 42 hrs, numerous nerve cells in the cerebrum and cerebellum showed necrosis making evident the Bragg-peak band. Striking demyelination in the irradiated part of the cortex was evident at the 96-hr period, and was most prominent in the Bragg-peak band. With time, the demyelination became still more profound. The myelin destruction was considered to be due chiefly to a direct effect of ionizing events on the myelin. Axis cylinders were much less radiosensitive than the myelin. At about the 16th day after irradiation, regenerative processes were seen. The end-stage of fiber regrowth was between the 4th and 7th month after irradiation. This new growth was considered an expression of an innate capacity possessed by the central nervous system for continual axonal regrowth. Only reactive microglia-like cells were present in abundance in the region of axonal regrowth. Whether oligodendroglia had any influence on the remyelination could not be determined. Astrocytes appeared not to be implicated. Many axis cylinders were damaged or destroyed in areas of irradiated cortex above the band. (TCO)

69 THE RADIATION RESISTANCE OF SUBSTRAINS FROM STREPTOCOCCUS FAECIUM SELECTED AFTER IRRADIATION OF TWO DIFFERENT STRAINS. Christensen, Ebbe Ahrensburg; Kjems, Ebbe (Statens Seruminstitut, Copenhagen). Acta Pathol. Microbiol. Scand., 63: 281-90(1965).

Previously it was shown that in the dry state S. faecium possesses considerable resistance to ionizing radiation. In the present study, 17 substrains were selected from two S. faecium strains, after the latter had been exposed to ^{60}Co γ or to electron irradiation with doses between 1.2 and 3.5 Mrad. The resistance of the parent strains and the substrains to ionizing radiation was then examined by determining the inactivation curves of each strain. Five of the 17 substrains examined had a higher resistance than the strain from which they were isolated. Eight substrains had unchanged resistance, and four had a lower resistance than the strain from which they were isolated. In the substrains isolated, no correlation was demonstrated between resistance to ionizing radiation and the cultural and biochemical characteristics examined. When subcultures in broth were examined in the microscope, either after gram staining or by phase-contrast microscopy of unstained preparations, some strains showed clumping of diplococci and chain formations, but these phenomena were not correlated with the radiation resistance of the strains. After growth for 1 to 4 days on blood agar at 37°C, all the strains developed β-hemolytic colonies. All strains were resistant to methylene blue (0.1%), and grew on 40% bile agar; they broke down arginine and fermented mannitol, arabinose, glucose, maltose, lactose, trehalose, salicin, and esculin. None of the strains grew on a solid medium containing potassium tellurite in a concentration of 1:2500 or fermented sorbitol, melizitose, raffinose, inulin, and glycogen. The most resistant substrains studied had a resistance of the same order of magnitude as Micrococcus radiodurans. (BBB)

70 IMMUNIZATION EXPERIMENTS WITH IRRADIATED LARVAE. III. THE EFFECT OF X-RAYS UPON EGGS AND LARVAE OF SYNGAMUS TRACHEA. Varga, I. (Univ. of Veterinary Sciences, Budapest). Acta Vet. Acad. Sci. Hung., 14: 411-18(1964).

Eggs of Syngamus collected from artificially infected New Hampshire chickens were x irradiated at the 4th, 8th, or 16th stage of segmentation. Development of the embryo and larvae was then observed. Irradiation was given at a dose rate of 573 R/min to total doses up to 80 kR. The morula stage occurred in 95% of the control eggs, in 90% of eggs exposed to 5 kR, in 75% of eggs exposed to 10 kR, in 5 to 10% of those irradiated with 20 to 80 kR. In 85% of control eggs the first-stage larva was visible; the same stage had been reached by only 2% of the eggs exposed to 5 kR. Most eggs of the other groups showed the morula stage, while 6 to 10% remained in the 8- to 16-blastomere stage. Thus the eggs of Syngamus trachea, as compared with those of other nematodes, are strikingly sensitive to irradiation, and the administered x-ray doses proved to be excessive. An x-ray dose as small as 4 kR was sufficient to check the migration of worm larvae into the trachea. Chickens were also exposed to infection with nonirradiated larvae (group A), with larvae treated with 1 kR (group B), 2 kR (group C), 3 kR (group D), 4 kR (group E), and 8 kR (group F). On the 8th day following infestation all birds of groups A, B, and C, and most birds in group D showed worms, while in group E and F no worms could be detected until the 41st day. Birds in groups A, B, and C died of syngamosis. In birds of groups B, C, and D the worms reached the trachea, copulated, and grew to the size of adults, though in worms recovered from group D, deficiently developed female gonads were apparent. (TCO)

71 EFFECT OF MITOMYCIN-C ON THE FREQUENCY OF CHROMOSOME ABERRATIONS PRODUCED BY X-RAYS. Matsuura, Hajime; Tanifuji, Shigeyuki; Saho, Takashi; Iwabuchi, Masaki (Hokkaido Univ., Sapporo). Am. Naturalist, 97: 191-3(May-June 1963).

Results are reported of experiments utilizing mitomycin-C, which is known to inhibit specifically the synthesis of DNA at low concentrations, in combination with x rays. Cut stems with flowers of Trillium kamtschaticum were placed in 20-μg/ml solutions of mitomycin-C for 14 hr. Eight hr after initiation of this treatment, the materials were irradiated with x rays at 60-R doses (8.1 R/min, 180-kv). Six hr after irradiation the materials were transferred to tap water. The ovules were hydrolyzed with 1N HCl at 60°C, and stained with leuco basic fuchsin. Simple mitomycin-C treatment did not cause any chromosome aberrations. Metaphase cells, fixed 48 hr after irradiation, were scored for chromatid and isochromatid breaks and various types of exchanges. The frequency of simple breaks and the breaks rejoined to form exchanges, scoring both chromatids and isochromatids, are shown. These results show that mitomycin-C modified the pattern and the frequency of chromosome aberrations. The yield of exchanges was markedly increased and the total frequency of all visible breaks also increased after the combination treatment. Although it is not possible to decide with certainty whether mitomycin-C affects the breakage event or the restitution-recombination process only, both the increase of the total frequency of detectable breaks and the increase of exchanges are inter-

preted by assuming that the rejoining of broken ends is inhibited by mitomycin treatment. Mitomycin-C prevents the rapid rejoining of x-ray induced breaks, and, prolongs the duration of an open period during which broken ends retain their potential rejoinability. The longer the open period, the less the chance of restitution, because the broken ends originating from a single break may become separated from each other. After the recovery of rejoinability following removal of the mitomycin effect, the broken ends which escaped restitution could participate in the formation of exchanges resulting in the observed increased frequency. Mitomycin-C inhibits DNA synthesis specifically without affecting RNA synthesis; hence, the marked modification by mitomycin-C of the pattern and the frequency of x-ray induced chromosome aberrations indicates an involvement of DNA synthesis in the process of rejoining. (BBB)

72 RELATIVE BIOLOGICAL EFFECTIVENESS OF 14.1 Mev NEUTRONS IN KILLING DORMANT SILKWORM EGGS. Murakami, Akio; Kondo, Sohei (National Inst. of Genetics, Misima, Japan). Ann. Rep. Nat. Inst. Genet. (Misima, Jap.), No. 14, 106-7(1963).

Although the lethal effects of low ion density radiations, such as x or γ rays, upon silkworm eggs have been studied by many investigators, little is known about the effects of high ion density radiations. A study of RBE in mutation induction by high energy neutrons in dormant silkworm eggs was made. In these experiments the biological effectiveness of 14.1-Mev neutrons was compared with that of γ radiation as concerns their killing effects on silkworm eggs in dormancy. The exposure to 14.1-Mev neutrons was conducted with the Cockcroft-Walton accelerator. Dormant silkworm eggs were exposed to neutron beams at a distance of 6.3 cm from the tritium target for a variable length of time, from 60 to 180 min. The neutron dose-rate was 5 rad/min and the total doses given were 500, 1000, and 1500 rad. In paralle1 to this, ^{137}Cs γ-ray treatment was carried out on the same material. The γ-ray doses were 500, 1000, 3000, and 5000 R at a dose rate of 100 R/min. The percentages of hatchability were plotted against doses given on semilogarithmic scale both for fast neutrons and γ rays. The hatchability curve after exposure to 14.1-Mev neutrons declined more rapidly than that for ^{137}Cs γ rays. The calculated doses that allow 50% hatchability (LD_{50}) were 600 rad and 2000 rad for 14.1-Mev neutrons and ^{137}Cs γ rays, respectively. Thus 14.1-Mev neutrons are more effective than ^{137}Cs γ radiation with regard to their killing action. The RBE thus calculated was 3.3. (BBB)

73 PHOTOALLERGY AND PHOTOSENSITIVITY DUE TO SYSTEMICALLY ADMINISTERED DRUGS. Storck, H. (Universitaet, Zurich). Arch. Dermatol., 91: 469-82(May 1965).

Skin sensitivity to uv radiation in patients treated with various drugs which strongly absorb uv radiation is considered. All three groups of photosensitizing drugs, sulfonamides, phenothiazines, and tetracyclines, are photodynamically active; they absorb in long wave uv, the latter also in visible light. Some in vitro experiments concerning photooxidation through uv light are discussed in terms of the etiology of photoallergy. These experiments concern p-hydroxyaminobenzenesulfonic acid amide (PHABSA) with the sulfonamides, sulfoxide formation with the phenothiazines, pigment formation with sulfonamides and phenothiazines, discoloration with demethyltetracycline, and photoalbumin complexes with sulfonamides. Formation of PHABSA is probably significant. The significance of color formation through uv irradiation with sulfonamides and phenothiazines seems important, as does the decoloration with demethyltetracycline. The photodimerization of promethazine and the formation of a photoalbumin complex with sulfonamides is of questionable importance. Sulfoxide formation with promethazine is certainly not active. There is as yet no generally valid mechanism known for the formation of photoallergens. (TCO)

74 ULTRAVIOLET-INDUCED ACANTHOLYSIS IN PEMPHIGUS. Cram, David L.; Winkelmann, R. K. (Mayo Clinic, Rochester, Minn.). Arch. Dermatol., 92: 7-13(July 1965).

It was found that uv light will produce a preacantholytic state in normal skin of patients with pemphigus so that positive results to the Nikolsky test with microscopic acantholysis are easily obtained. The response to uv light varies; in some individuals, the delayed erythemal dose (DED) is necessary to induce acantholysis, and in others a minimal erythemal dose (MED) is sufficient. This report presents results of uv-induced acantholysis in patients with pemphigus. Seven patients with pemphigus foliaceus were subjected to light patch tests consisting of a 30-sec MED and a three-min DED using a standard Hanovia hot quartz lamp at a distance of 30 in. Such irradiation produced an acantholytic phenomenon in normal skin of all seven patients with pemphigus foliaceus. In six, this reaction was manifested by a positive Nikolsky sign and confirmed by biopsy in four. Friction alone, irradiation, occlusive dressing, and a rubefacient failed to produce a similar reaction. The thermal burn in the skin of patients having pemphigus was of subepidermal type. The uv-induced acantholysis was inhibited by chloroquine phosphate, taken orally, in the two patients tested. Prednisone had no such effect. It is concluded that uv light is a major aggravating stimulus for pemphigus foliaceus. It is proposed that the uv phototoxic effect is a two-stage process: (1) release of the inhibition of acantholysis, and (2) production of the clinical lesion by trauma. Continued study of the specific wavelengths that are necessary to cause this reaction may demonstrate more clearly the mode of action of uv light. (BBB)

75 RECORDING LENS OPACITIES. Christenberry, Kenneth W.; Upton, Arthur, C.; Conklin, James W. (Oak Ridge National Lab., Tenn.). Arch. Ophthalmol., 72: 667-9(Nov. 1964).

A grading system is described that can be used for recording the extent of injury of the mouse lens. A numerical grading system was set up by which the opacities were divided into four grades of severity, ranging from one to four. Subsequently, the grading system was improved by estimating the proportion of the lens appearing to be opacified on slit-lamp examination, scoring the estimate on a scale of 0 to 100%. Development of spontaneous opacities is described. The described method of scoring the progression of lens changes enabled more quantitative comparison than hitherto the effects of different doses and types of radiation on the mouse lens. It also permitted quantitative comparisons between the effects of radiation and of radiomimetic and cytotoxic chemicals. (TCO)

76 RESISTANCE OF THE BIOSYNTHESIS OF HEMOGLOBIN IN CHICKEN RETICULOCYTES TO X IRRADIATION. Schall, H.; Turba, F. (Universitaet,Wuezburg, Ger.). Biochem. Z., 339: 224-32(Dec. 3, 1965). (In German).

In vivo and in vitro experiments were carried out with White Leghorn chickens to test the radiosensitivity of hemoglobin synthesis under both conditions. The chickens received a 1000 R surface dose of 100-kv x rays, whereas in in vitro studies, reticulocytes in plasma or saline were irradiated with 100-kv x rays in doses up to 6000 R or with 29-kv x rays to 60,000 R. Irradiation of hen reticulocytes in salt solution resulted in increased hemolysis, whereas irradiation in citrate plasma showed no such effect. Doses up to several thousand R had no noticeable influence on hemoglobin biosynthesis. This was demonstrated by the incorporation of ^{14}C- and ^{3}H-labeled leucine into both the total hemoglobin fraction and the electrophoretically different components, as confirmed by cross-labeling of irradiated and nonirradiated samples with ^{14}C and ^{3}H respectively. No structural differences could be noted in the irradiated hemoglobin samples by the fingerprint method and ensuing radioautography. Even in vitro irradiation at doses up to 60,000 R did not depress the oxygen consumption of reticulocytes. The results showed that, under the conditions used, no genetic defects were induced in the DNA controlling hemoglobin synthesis, as seen by the peptide structures of the protein. (BBB)

77 CHANGES IN BLOOD LIPIDS IN IRRADIATED RATS WITH REFERENCE TO THE AGE OF THE ANIMALS AND TO THE DOSE OF X IRRADIATION GIVEN. Angelico, R.; Casparini, G.; Cavina, G.; Moretta, L.; Quintiliani, M. (Istituto Superiore di Sanita, Rome). Boll. Soc. Ital. Biol. Sper., 41: 310-12(Mar. 31, 1965). (In Italian).

As is well known, a marked hyperlipemia occurs 24 to 36 hr after whole-body ionizing irradiation. This phenomenon is especially noted in rabbits, and to a less degree in other species. However, insufficient information is available for understanding of this postirradiation hyperlipemia. To investigate the site of mobilization of the lipids, liver and serum lipids were determined in Long-Evans rats at various ages and intervals after irradiation with different x ray doses. In preliminary studies, a single supralethal dose (1000 R) was shown to significantly alter liver and serum lipids by 36 hr after irradiation and maximally so at 74 hr. However, the percentage of lipids in liver remained constant while liver weight increased. It was also found that the mobilized lipids in serum consisted mainly of cholesterol, phospholipids, and triglycerides. Liver showed a decrease in cholesterol content. When 1000-R doses of x rays were given to rats of various ages, rats 30 days of age showed no response, while rats 45 days and older showed a rise in serum lipids, an increase in liver weight, and an increase in liver lipid concentration (mg/g fresh weight) 48 to 72 hr postirradiation. When the x ray dose was varied, a dose-dependent rise in serum lipids was noted 48 hr later: from 3% increase after 300 R to 48% increase after 1000 R. The same relation was seen at 72 hr postirradiation (+7% after 300 R to +63% after 1000 R). The level of significance at both intervals was reached with the 600 R dose. (BBB)

78 THE MUCUS-DEPLETING ACTION OF BILE IN THE SMALL INTESTINE OF THE IRRADIATED RAT. Sullivan, M. F.; Hulse, E. V.; Mole, R. H. (Pacific Northwest Lab., Richland, Wash.). Brit. J. Expti. Pathol., 46: 235-44(June 1965).

Bile salt absorption was measured by a tracer technique. Carboxylabeled ^{14}C-cholic acid was injected intraduodenally into an unirradiated, doubly cannulated rat and its bile was collected for the next two hrs. Within the first 30 min, 85% of the administered radioactivity was found in the bile. After absorption from the intestine the ^{14}C-labeled cholic acid was converted into taurocholic acid in the liver of the rat and the labeled taurocholic acid was then excreted by the liver into the bile. Bile salt recirculation tested by this method did not seem to be affected by 1000-R doses of x rays, indicating that absorption of bile salt by the intestine was not markedly affected by gross cellular damage. The occurrence of diarrhea on the third and fourth days after abdominal irradiation of the rat by 1000 R was apparently related to an increased sensitivity at the time to the mucus-depleting action of the bile. The histological changes found in the small intestine of rats after partial-body irradiation are described. (TCO)

79 POST-RADIATIONAL REGENERATION OF YEAST CELLS DURING THE STATIONARY PHASE OF GROWTH. Barsukov, V. S.; Malinovskii, O. V.; Mityushova, N. M. (Inst. of Physiology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 161: 228-9(Mar. 1, 1965). (In Russian).

The regeneration ability of two strains of tetraploid yeast (Saccharomyces cerevisiae) cells that were irradiated with ^{60}Co to 22,000 and 55,000 rads, respectively, was studied. Preliminary work showed that on nutrient agar the increase in the number of cells ceased after three days, and three-day cultures were considered in the stationary growth phase. Viability data showed that the cells are able to regenerate in the stationary phase. The recovery rate on agar was comparable to that in water, being the same for one strain and slightly less for the other. Therefore, placing the cells in water is not an essential condition for recovery and only delays multiplication. A delay in multiplication by eliminating or decreasing the nutrient material increases the recovery time, which was shown to be possible only up to the first division of the irradiated cells. Possibly the optimum amount of nutrient necessary for growth does not stop but even accelerates the recovery rate, but shortening of the recovery time by increasing the multiplication rate results in decreased viability. (TTT)

80 MUTAGENIC EFFECT PRODUCED BY IONIZING RADIATION OF AN EXTRACELLULAR PHAGE. Kriviskii, A. S. (Inst. of Radiation and Physico-Chemical Biology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 161: 707-10(Mar. 21, 1965). (In Russian).

The viability of phage that was x irradiated in bouillon decreased linearly with increasing dose from 100 to 500 kR. At the same time the mutagenic effect decreased linearly. The indirect action of ^{137}Cs gamma radiation from 30 to 50 kR, at a rate of 344 or 700 R/min, was studied on phage in buffer (salt) solution; these doses have practically no mutagenic effect on phage in bouillon. The results showed that with increasing free radicals of water and peroxide the lethal effect increased. Viability decreased much more rapidly in buffer solution than in bouillon. The mutagenic rate increased rapidly in buffer solution. Phage is thus a very convenient material for studying DNA mechanisms. The phage model may be used for studying not only the quantitative relationships of radiation mutagenesis under molecular conditions, but also for studying protective substances and antimutagenic effects in postirradiation metabolism. (TTT)

81 MUTATION RESEARCH IN PEAS. Heringa, R. J. (Foundation for Agricultural Plant Breeding, Wageningen, Netherlands). Euphytica, 13: 330-6(Oct. 1964).

Various kinds of ionizing radiations were used in attempts to induce economically useful mutants in peas. Dry seeds of the pea variety Pauli were irradiated with 15,000 or 18,000 R doses of x rays, 18,000 R of γ rays, and with neutrons. In addition the chemical mutagen ethyl methane sulfonate (EMS) was used, in concentrations of 0.33% and 0.50%. After raising the seedlings of irradiated seeds in a greenhouse, surviving plants were planted in the field. The germination capacity was only slightly disturbed after irradiation; however, it was greatly reduced after EMS treatment. A very large number of seedlings did not grow further, their roots showing a deep brown discoloration, ultimately leading to plant death. Several other factors after planting in the field killed many other plants. The fertility of the M_1 generation was only slightly impaired by the irradiation, but markedly so by the EMS treatment. In the M_2 generation, both after irradiation and after EMS treatment, at higher doses and concentrations lower percentages of mutated progenies were found than at lower dosages and concentrations. This was presumably due to the fact that the number of plants per M_2 line in the former case was on average twice as high. The percentage of progenies with mutations and the percentage of mutated plants was larger after EMS treatment than after irradiation. From normal looking plants with a good fertility, progenies were raised in nonreplicated small plots. The average yield per plant and the distribution in the irradiation series did not differ significantly from that of the untreated material. After EMS treatment the average yield was significantly lower and the distribution significantly higher. The fertility impairment caused by EMS, therefore, also became manifest in the M_3 generation. (BBB)

82 THE RESPONSE OF THE CORNEA OF THE ADULT AXOLOTL (SIREDON MEXICANUM) TO X-RADIATION. Brunst, V. V. (Roswell Park Memorial Inst., Buffalo). Exptl. Eye Res., 4: 127-34(June 1965).

To compare the effects of x rays on the cornea of adult salamanders with those found earlier on young ones, the anterior portion of the head was irradiated in 70 adult axolotls, 4-5 yr old, using 1000 R in 9 animals, 3000 R in 20, 6000 R in 10, 8000 R in 11, and 10,000 R in 20. Specimens fixed at various intervals following irradiation were studied histologically. After irradiation with 1000 R, the substantia propria of the cornea was almost normal. The corneal epithelium, however, became much thicker, and melanophores and Leydig cells developed in it. After irradiation with 3000 R, the substantia propria was much thicker than nor-

mal, and underwent stratification; cavities and pigment cells developed in it. Many histopathological changes are related. (TCO)

83 STERILIZATION OF THE NAVEL ORANGE-WORM, PARAMYELOIS TRANSITELLA (WALKER), BY GAMMA RADIATION (LEPIDOPTERA: PHYCITIDAE). Husseiny, Mohamed Mamdouh (Univ. of Aleppo, Syria); Madsen, Harold F. Hilgardia, 36: 113-37(Dec. 1964).

The feasibility of radiation control for the navel orange-worm was explored. Experimental work covered the steps necessary for actual field tests: observations on the mating behavior of the moth, development of techniques for mass culture, study of radiation procedures and doses, and tests of the effectiveness of sterilized moths in reducing fertile matings in a normal population. (TCO)

84 FAST-NEUTRON EFFECTS ON PRODUCTIVITY OF YOUNG AND OLD FLOUR BEETLES, TRIBOLIUM CASTANEUM. HERBST, AND ALTERATIONS AT DIFFERENT TEMPERATURES AND AFTER EXPOSURE OF EITHER OR BOTH SEXES. Erdman, Howard E. (Battelle-Northwest, Richland, Wash.). Int. J. Radiat. Biol., 9: 305-11(1965).

Virgin day-old and three-week-old flour beetles, Tribolium castaneum, were given approximately 830 and 970 rads, respectively, of 4.6 Mev fast neutrons. Ten replicates of mating combinations in which neither sex, one sex, or both sexes were exposed were cultured at 25, 29, and 32°C in 65 to 70% relative humidity. Productivity, measured as adult progeny per reproducing female per day, was scored for 14 days. Decreases in temperature progressively delayed reproductive onset. Further delay in reproductive onset occurred when young female beetles were irradiated, indicating a greater radiation sensitivity of immature oogonia. Productivity of young beetles reached a plateau during the second week; that of old beetles after the first day. When one sex was irradiated, productivities were not significantly different within a temperature, but were less than when neither was exposed and more than when both sexes of a pair were exposed. (auth)

85 THE EFFECT OF RADIATION ON THE ACTIVITY OF RETICULOENDOTHELIAL CELLS IN ORGAN CULTURES OF LYMPH NODE AND THYMUS. Gilman, R.; Trowell, O. A. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 9: 313-22(1965).

Functional activity of the RE cells in organ cultures of lymph node and thymus of rats was explored by observing their ability to take up and segregate various colloidal dyes and various preparations of iron. Sodium carmine (50 mg % in serum-containing medium) was the most satisfactory test substance, and the percentage of RE cells that had segregated dye after exposure for 24 and 48 hours was determined from cell-counts made on film preparations. In cultures subjected to 10, 20 or 40 kR of x radiation before exposure to carmine, the percentage of active RE cells was somewhat higher than in controls. It was concluded that the ability of these RE cells to segregate colloidal dye was not impaired during the first two days after doses up to 40 kR. Even after 100 kR most of the cells were active until their death on the second or third day. In normal cultures exposed to a mixture of trypan blue and sodium carmine, it was noticed that some cells took up trypan blue only, whereas closely adjacent cells might take up carmine only. (auth)

86 THE EFFECT OF RADIATION ON THE PARENT TO F_1 HYBRID GRAFT-VERSUS-HOST REACTION. Blackett, N. M. (Royal Cancer Hospital, London). Int. J. Radiat. Biol., 9: 323-32(1965).

The effect of x radiation on the graft-versus-host reaction produced by injecting spleen cells of the parental strain into the F_1 hybrid cross between two inbred strains of rat was studied. Two separate measurements of the intensity of this reaction have been used: the enlargement of the spleen, and the degree of dilation of the peripheral blood vessels. This reaction is increased by irradiating the hybrid recipients prior to injecting parental-strain spleen cells from normal animals. The survival has been determined of irradiated parental-strain spleen cells obtained from rats that were alive at the time of irradiation and also of cells obtained from rats killed a few minutes before irradiation. The results suggest that spleen cells which take part in the graft-versus-host reaction are well oxygenated in the living rat and have approximately the same sensitivity as mouse lymphoid cells which take part in similar homograft reactions. There appears to be no difference in the sensitivity of cells irradiated in vivo and in vitro under the same conditions of oxygenation. However, spleen cells taking part in the homograft reaction are less sensitive than spleen cells that produce antibody. (auth)

87 THEORETICAL GROWTH-RATE CURVES FOR VICIA FABA ROOTS UNDER CONTINUOUS RADIATION EXPOSURE AT LOW DOSE-RATE: A COMPARISON WITH EXPERIMENTAL RESULTS. Oliver, R.; Shepstone, B. J. (Churchill Hospital, Oxford). Int. J. Radiat. Biol., 9: 333-47(1965).

Using models for the root tip meristem of Vicia faba proposed previously, theoretical curves of growth-rate were computed for conditions of continuous x or γ radiation exposure at low dose-rate (1 to 10 rads/hr). These are compared with experimental results. The best agreement is obtained assuming cell death at the second division radiation damage, allowing for some gradual increase in cell cycle time during irradiation and postulating that, at any rate at the lower dose-rates, sterilized cells differentiate and contribute to root elongation. The match between theoretical and experimental curves suggests a value for D_0 of about 240 rads for the single hit type of mechanism assumed to apply at these dose-rates. It is predicted that if the cell-cycle time is varied, similar growth-rate curves should be observed for the same dose received per cell cycle, rather than for the same dose-rate. (auth)

88 CELL-CYCLE AND RADIOSENSITIVITY OF THE CHROMOSOMES OF HUMAN LEUKOCYTES. Brewen, J. G. (Oak Ridge National Lab., Tenn.). Int. J. Radiat. Biol., 9: 391-7(1965). (ORNL-P-928).

Cultures of human peripheral leukocytes were x irradiated in the different stages of the cell-cycle, i.e., G_1, S, and G_2. The data show the G_2 cells had more aberrations per unit dose than cells in S or G_1, and G_1 cells had more two-break aberrations. These apparent variations in stage sensitivity are interpreted as resulting from spatial relations of the chromosomes in the interphase nucleus and not from differences in the sensitivity of the chromosome strand to breakage. (auth)

89 NUCLEIC ACID METABOLISM IN THE LENS. III. EFFECT OF X-RADIATION. Lerman, Sidney; Zigman, Seymour (Univ. of Rochester, N. Y.). Invest. Ophthalmol., 2: 626-9(Dec. 1963).

Increased in vivo incorporation of ^{32}P into the albuminoid RNA fraction of the rat lens occurs 6 hr after the animal had been exposed to x radiation (1500 R). The in vitro uptake of ^{32}P and ^{14}C-adenine by albuminoid, ribosomal, and soluble RNA fractions of normal and x-irradiated rat lenses was measured. The RNA fractions were extracted by sodium dodecyl sulfate in 0.9% NaCl. The specific RNA fractions were also hydrolyzed, chromatographed, and the activity of the individual nucleotides (as well as the specific RNA fractions) was determined. An experiment was also performed in which the lens capsules were removed (after 3-hr incubation) and the activities determined in the nucleic acids extracted from the capsules and in the three RNA fractions of the remaining lens matter. The results indicated that the incorporation of ^{32}P and ^{14}C-adenine into albuminoid RNA was markedly stimulated 1 hour after 1500 R whole-body irradiation. There was no significant effect on ribosomal or soluble fractions. The effect of formaldehyde and heating on x-irradiated albuminoid RNA was much less than on the albuminoid RNA derived from control animals. This indicates that there may be a physical change in the albuminoid RNA molecule after x irradiation, possibly due to radiation-induced breakage of the RNA strand in the main chain. Although the viscosity measurements failed to reveal significant changes in lens albuminoid RNA, it is still possible that breakage of the molecule

occurred. Random breaks in the albuminoid RNA could account for an increased incorporation of $^{32}PO_4$ or ^{14}C-adenine that would occur by addition of isotopes to the free ends of the molecule. (BBB)

90 MEDICAL FINDINGS IN MARSHALLESE PEOPLE EXPOSED TO FALLOUT RADIATION: RESULTS FROM A TEN-YEAR STUDY. Conard, Robert A.; Hicking, Arobati (Brookhaven National Lab., Upton, N. Y.). J. Am. Med. Assoc., 192: 457-9(May 10, 1965).

This report summarizes the medical findings over a ten-year period of the 82 people of Rongelap Island who were exposed to fallout. Medical evaluation of the health status of the exposed people has revealed about the same incidence of illness and disease as noted in the unexposed population, with certain exceptions. Annual hematologic follow-up studies revealed that the levels of white blood cells and platelets of the peripheral blood in the exposed group never quite reached the levels of the unexposed comparison population. Fertility, miscarriages, stillbirths, and genetic effects were not apparent. Boys exposed at 1 to 5 years of age showed retardation of statural growth as well as bone age, and this was most marked in those boys exposed at 12 to 18 months of age. Benign thyroid nodules were removed from three teenage Rongelap girls ten years after exposure from fallout. (The thyroid dose received was estimated at about 1000 rad, largely from radioiodines absorbed.) No thyroid nodules were detected in 75 unexposed children. No cases of leukemia in either the exposed or unexposed Rongelapese were detected. An increased number of pigmented nevus-like lesions were noted in previously irradiated areas of the skin but these have been benign. Neither chronic radiation nor evidence of cancer of the skin was noted. Radiochemical urine analyses and whole-body spectrometric analyses revealed that the body burdens of radioisotopes in the exposed Rongelap people fell rapidly, so that by two years after exposure the levels were far below the stated max permissible levels. (BBB)

91 THE EFFECTS OF A DOSE OF 2,000 ROENTGENS OF X-RAY IRRADIATION ON THE GROWTH OF THE JAWS IN KITTENS. Donohue, W. B. (Univ. of Montreal). J. Can. Dental Assoc., 28: 22(Jan. 1962).

Twenty-one kittens of from three to four months of age were subjected to a localized dose of 2000 R of x rays given in two doses, seven days apart. Both sides of the skull were irradiated, their bodies being protected by a lead box. Some animals received injections of alizarine red S at regular intervals, in addition to the irradiation. The animals were sacrificed at postirradiation periods of from two months to one year, and the skulls were sectioned in the sagittal plane, examined radiographically, demineralized, and histological sections prepared. Following irradiation the histodifferentiation of the odontoblasts ceased, they became fewer in number, and reverted to a low cuboidal type cell. These altered odontoblasts were associated with the formation of a primitive type of dentin, or osteodentin. The odontoblasts that underwent differentiation before the animal was irradiated continued to form normal dentin at a nearly normal rate. When irradiation was administered during the root-forming stage of the teeth, morphodifferentiation and histodifferentiation ended abruptly. However, when the teeth were irradiated during their crown-forming stage, the coronal portions completed their development before growth in length ceased. In many instances, these rootless teeth erupted into the mouth. The cessation of morphodifferentiation was associated with a gradual sealing off of the pulpal tissues by osteodentin. This bony tissue sealing the pulp was frequently formed around a nidus of dystrophic calcification. All of the irradiated animals showed a gingival inflammatory response, sometimes associated with a partial cervical resorption of permanent incisor teeth. Frequently, firmer areas of dental resorption became overlayed with bone, with a resultant ankylosis. Ankylosis of some teeth was usual in animals that survived eight months or more. Lateral skull radiographs showed significant differences in dimensions of the jaws of experimental and control kittens. (BBB)

92 SEX AS A FACTOR IN POSITION-POSTREMITY RESPONSES OF RHESUS MONKEYS. Brown, W. Lynn; McDowell, A. A. (Univ. of Texas, Austin). J. Genet. Psychol., 103: 331-4(Dec. 1963).

Attempts were made to ascertain if female monkeys with previously demonstrated superiority to male monkeys both on identical-cue, spatial delayed-response problems and on discrimination problems with reduced stimulus cues, show a greater tendency to position-postremity responses than male monkeys when the requirements of the test situation place no special premium on such responses. Thirty-three male and 23 female rhesus monkeys were employed, 50 of which had been exposed to nuclear radiations at the Nevada Test Site almost four years before the present study was initiated. Each animal was given 42 training trials every day for four days on a black-white discrimination. Eight test trials, trials presenting two black (positive) stimuli, were interspersed among each day's training trials. Each response during test trials which was to the same position as the immediately previous training trial was recorded as a position-postremity response. Analysis of the position-postremity data for the last three days of testing showed that the frequency of position-postremity responses was significantly greater for the female than for the male subjects. The proportion of females showing greater-than-chance frequency of position-postremity responses was significantly larger than chance and the proportion of males. Statistical analysis of the frequency data, using a nonorthogonal analysis of variance procedure, failed to yield significant results for the radiation variable, but gave a sex effect which was beyond the 0.005 significance level. (BBB)

93 BIOCHEMICAL CHANGES IN RAT EPIDERMIS INDUCED BY CHRONIC ULTRAVIOLET-LIGHT EXPOSURE. Ogura, Ryohei M. (Kurume Univ. School of Medicine, Japan). Kurume Med. J., 11: 133-8(1964).

Changes of sulfhydryl (SH) compound content in epidermis of albino rats were observed after chronic exposure to uv light for seven months. The total energy received was 8.5×10^7 erg/cm^2, delivered by two-min daily exposures. Chronic exposure caused the nonprotein-bound SH content to decrease, but protein-bound SH and disulfide content remained relatively unaltered for three months exposure. The polarographic filtrate wave height showed a gradual decrease. The DNA content of epidermis decreased significantly, but no significant difference was found in RNA content. The diameter of nuclei showed a decrease, but a significant change in the number of nuclei was not detected. To investigate the possibility that serum SH level reflect tissue level, the serum sulfhydryl level was determined in the same animals. The serum SH level in the unexposed control was 35 ± 2.3 μM/100 ml and decreased significantly, while the disulfide content remained in the normal range (75 to 85 mg/100 ml). The polarographic filtrate wave height showed a gradual increase (from 11.4 μA to 28.6 μA). (TCO)

94 X RAYS AND PHILADELPHIA CHROMOSOME. Engel, Eric (Vanderbilt Univ., Nashville). Lancet, 2: 291-2(Aug. 7, 1965).

The presence of the Philadelphia chromosome in marrow cells of a man with chronic myeloid leukemia and previous x-ray exposure is reported. The case of a 49-yr-old male patient is related who was found to have chronic myeloid leukemia three years after chest irradiation for a lung carcinoma surgically removed (estimated skin dose of 10,560 R over a period of five weeks). The Philadelphia chromosome was clearly seen in peripheral-blood cultures. In addition, fibroblast cultures of a skin biopsy specimen taken from the site of previous chest x-ray therapy showed striking chromosomal rearrangements consistent with the presence of several radiologically induced clones in this solid tissue sample. The leukemogenic effect of ionizing agents, although well documented on a statistical basis, can only be suspected and not directly established in any particular patient with both leukemia and a previous history of radiation exposure. It would thus be very informative if others would report their experience with respect to the

presence or absence of the Philadelphia chromosome in cases of chronic myeloid leukemia arising under similar circumstances. (BBB)

95 THE EFFECT OF HYPEROXYGENATION ON THE RADIOSENSITIVITY OF THE HEPATIC TISSUE. Laddaga, M.; Romagnoli, U. (Universita, Pisa, Italy). Minerva Radiol., Fisioterap. Radiobiol., 10: 315-17(July-Aug. 1965). (In Italian).

The effects of radiation on the hepatic tissue were studied under two experimental conditions: irradiation in air or in oxygen atmosphere. The measurement of the damage induced was the index of abnormal mitoses observed during the regeneration after partial hepatectomy. White rats were exposed to a ^{60}Co γ source for a whole-body exposure of 500 R. Immediately after the irradiation the animals had a partial hepatectomy. The index of abnormal mitoses in the regenerating liver of the normal rats was on an average 5% whereas the exposure of the animals to an atmosphere of O_2 at 2 atm caused a mean value of 8%. The difference between these two values was not significant; the radiation in air caused a sharp increase of the index up to a mean value of 24%. The animals irradiated in an O_2 atmosphere had a mitotic index of more than 31%. The statistical analysis shows that the difference between the two indices is not significant. (J.S.R.)

96 EXPERIMENTS ON THE RADIOSENSITIVITY OF HEMATOPOIETIC STAMINAL CELLS. Silini, G.; Pozzi, L. V. (Centro Studi Nucleari, Casaccia, Italy). Minerva Radiol., Fisioterap. Radiobiol., 10: 332-5(July-Aug. 1965). (In Italian).

The hematopoietic capacity of embryonic liver and the radiosensitivity of staminal cells of the liver of mice were studied. Staminal cells are defined as the cells capable of inducing splenic colonies when they are injected into irradiated animals. Two aspects of the experimental studies are briefly reviewed. The first is the determination of the variation of absolute number and percentage of staminal cells in embryonic liver as a function of the embryonic age. Graphs showing these data are presented. Radiation inactivation curves for staminal cells in vitro and in vivo are also given. The radiosensitivity of the embryonic liver cells are also examined and compared with the radiosensitivity of bone marrow cells of adult animals. (J.S.R.)

97 LACK OF INTERACTION OF X-RAY- AND NEUTRON-INDUCED CHROMOSOME BREAKS IN BARLEY. Heddle, John A. (Univ. of Tennessee, Knoxville). Mutation Res., 2: 149-55(Apr. 1965).

Attempts were made to demonstrate a difference between the kinetics of two-break chromosome aberrations production by neutrons in barley and those in Vicia or Tradescantia; such a difference had been predicted from the data of Natarajan and Narayanan, which showed interaction of x ray and neutron-induced chromosome breaks. Barley (Hordeum vulgare) seeds with 8 to 9% moisture content were irradiated with 250-kvp x rays at a dose rate of 4000 R/min. Neutron irradiation was performed with a 250-kv linear accelerator using a deuteron beam impinging on a tritium target. This generates nearly monoenergetic 14.1-Mev neutrons with negligible γ contamination. The dose rate was about 2000 rad/hr. No significant increase over additivity (the sum of the yields of two-break aberrations produced by x rays and neutrons independently minus the control value) was observed, whether neutrons or x rays were given first. There was no significant difference between the aberration yield of irradiated seeds germinated immediately and the yield of those held until the combined-dose group were germinated, whether the irradiation was x rays or neutrons. The longest time between the end of the first and the beginning of the second dose in combined-dose treatments was 16 min; a period of 13 min was usual. Thus, these experiments demonstrated one-hit neutron kinetics and possible two-hit x-ray kinetics for two-break aberrations, and no quantitatively determinable interaction between x-ray- and neutron-induced chromosome breaks. The large one-hit component of the x-ray curve suggested that the rejoining distance may be even smaller in barley than in Vicia faba and Tradescantia. (BBB)

98 RELATIONSHIP OF THE VELOCITY OF A CHARGED PARTICLE TO ITS RELATIVE BIOLOGICAL EFFECTIVENESS. Turner, J. E. (Oak Ridge National Lab., Tenn.); Hollister, Hal. Nature, 208: 36-7(Oct. 2, 1965). (ORNL-P-1445).

An attempt is made to clarify the question of charge dependence of RBE by the application of general principles of collision theory. It was concluded that the validity of charge independence for RBE is equivalent to the validity of the first Borne approximation in quantum mechanics. Within the framework of this approximation, the concept of LET dependence for RBE should be replaced by the more precise velocity dependence. (P.C.H.)

99 VARIATION OF THE X-RAY SENSITIVITY OF SERRATIA MARCESCENS WITH RELATIVE HUMIDITY. Morrison, H. G.; Cormack, D. V. (Univ. of Saskatchewan, Saskatoon, Can.). Nature, 208: 91-3(Oct. 2, 1965).

The effects of atmospheric oxygen on the radiosensitivity of Serratia marcescens at various humidities was investigated in addition to the protective effects of inositol. The results showed that at the lower humidities there are two kinds of x-irradiation damage both in inositol-treated cells and in unprotected cells, with the humidity-dependent component in each case requiring the presence of oxygen. At lower humidities, inositol exerted most of its protective effect by reducing the oxygen-independent component of the radiation damage. (P.C.H.)

100 RADIATION MYELOPATHY. Verjaal, A. (Gemeenteziekenhuiz aan de Zuidwal, Gravenhage, Netherlands). Ned. Tijdschr. Geneesk., 108: 1123-7(June 6, 1964). (In Dutch).

A review of the pertinent literature reveals that prior to the present report no anatomically documented case of thoracic radiation myelopathy has been recorded. This report describes a patient who was treated with 4500 R telecobalt radiation on account of squamous cell carcinoma of the right lung. Six months after treatment, the Brown-Sequard syndrome developed at the eighth thoracic segment followed by complete transverse lesion. The patient died nine months after the onset of neurological symptoms. Autopsy findings included necrosis of the spinal cord in the thoracic segments 7 to 9. Hyaline degeneration and considerable thickening of the vascular walls were found in the transitional region towards the unaffected part of the spinal cord, and a moderate glial reaction was seen in this area. There was ascending degeneration in the cervical cord and descending degeneration in the lumbar cord. The clinical symptoms and histopathological findings corresponded with the pathological changes described in cases of cervical radiation myelopathy. Illustrations of the gross and microscopic findings are presented. (BBB)

101 THE EFFECT OF IONIZING RADIATION ON THE BIOLOGICAL ACTIVITY OF GLIOMAS. Mungyerova, G.; Kuzma, I.; Jacz, K. (Slovak Academy of Sciences, Bratislava). Neoplasma, 3: 285-8(1965).

The response of cells cultured from six human tumors (glioblastoma multiforme) to γ rays was studied. The cultures were obtained from the primary tumor and from secondary tumors after radiotherapy and surgery. All six patients had been given radiation with a total tumor dose of 4200 to 5300 R in the period between two operations. The explants of the primary tumor exhibited intensive growth and formed a rich growth zone, whereas growth in cultures of the recurrent tumor was restrained to single cells. In two cases, no decrease of growth activity in the cultures of recurrences was observed, when compared with the primary tumor. The cultures of primary tumor were irradiated in both cases with a dose of 8000 R. In one of them, the primary tumor was diagnosed as astrocytoma with rich cells content and moderate nuclear polymorphism. In vitro the tumor was resistant to a dose of 8000 R. The recurrent tumor exhibited a a typical picture of glioblastoma multiforme with intensive growth activity in vitro. In the second case the primary tumor was also irradiated with a dose of 8000 R. After this irradiation the growth stopped but no distinct morphological

signs of the cell injury were noted. Cells from the recurrence exhibited intensive growth, but after a single dose of 8000 R were also resistant. The results of these experiments demonstrate, that although the radiation therapy does not result always in elimination of glioblastoma multiforme, in the case of radiosensitive tumors, it exerts some influence upon its biological activity. In cases of radioresistant glioblastoma, growth activity was not changed after radiation. (BBB)

102 INVESTIGATIONS OF CHRONIC GAMMA IRRADIATION OF THE HEART, THE LIVER, AND THE KIDNEYS. Mikhailov, V.; Bozduganov, A.; Tsanev, K. (Postgraduate Inst. of Medicine, Sofia). Neoplasma, 3: 305-13(1965).

Four groups of C57B1 mice were irradiated for 10, 30, 120, and 180 days, respectively, with one-R daily doses of ^{60}Co γ radiation at one R/min. Histologic examination was made of heart, liver, and kidney. The liver showed only minimal changes after 10-day (10-R) irradiation, with Kupffer cells showing a slight proliferation. After 30 days (30 R) parenteral liver cells showed necrosis and some syncytium formation. Kupffer cells were proliferating markedly. Inflammatory cells (lymphocytes and polymorphonuclear leukocytes) were present. Liver of mice exposed for 180 days (180 R) showed marked necrosis and loss of regular structure, with incipient fibrosis (fibroblasts growing into periportal spaces). The kidney after 10 R showed nephrotic changes, as seen by alterations in convoluted tubule cells, but glomeruli were normal. After 30-R doses these tubule cells showed frank necrosis, and glomeruli were swollen. The glomeruli were reduced in volume after 120 R and perivascular fibrosis was present in the renal medulla. These changes were more marked in the 180-R group. Myocardium showed slight damage to muscle fibers after 30 R. These became necrotic and lacked nuclei after 120 R. Myofibril structure was completely disrupted in hearts of mice receiving 180 R, with fibrosis also being evident in this group at 180 days after irradiation was begun. These experiments demonstrate the radiosensitivity of these vital organs exposed to relatively low-dose chronic γ radiation. (BBB)

103 TITRATION OF ROUS SARCOMA VIRUS ON THE CHICK EMBRYO CHORIOALLANTOIC MEMBRANE. Vrba, M. (Inst. of Experimental Biology and Genetics, Prague). Neoplasma, 12: 159-65(1965).

Results of experiments with Rous sarcoma virus (RSV) and virus-producing cells of rat tumor XC on the chick embryo chorioallantoic membrane (CAM) are reported and discussed in terms of histogenesis of malignant centers (MC) on CAM, characteristics of statistical distribution of MC, resistance of embryo against the RSV infection, relation of MC production to the age of CAM in time of inoculation, and questions relating to the titration and concept of the infectious unit. The CAM model was further used in experiments designed to ascertain the proportion of cells of the rat tumor XC capable of RSV production and of RSV induction through the cultivation of XC tumors on the CAM. A cell suspension of a known number of cells (3×10^5 to 6×10^4/0.1 ml) was obtained from a tumor growing in vivo or in vitro and x irradiated in vitro by a dose of 5000 R. The quantitative response of CAM to the inoculation of x irradiation SC tumor cells did not show any dependence on the number of inoculated cells (3×10^5 to 6×10^4) and in all cases of dilution the number of proliferation centers predominated from 1 to 10 on one CAM. After transplanting a proliferation center to twelve 10-day old chicks, sarcoma growth was observed in two cases and histological examination showed that the assumed malignant centers resulting on CAM after inoculation of an x-irradiated XC tumor cell suspension are formed of four types of biologically differing proliferations. It was concluded that titration of x-irradiated cells on CAM would require detailed histological examination of each presumptive malignant center for the purpose of excluding the nonspecific inflammatory CAM reactions. (TCO)

104 THE BIOLOGY OF TISSUE TRANSPLANTATION. II. Russell, Paul S.; Monaco, Anthony P. (Massachusetts General Hospital, Boston). New Engl. J. Med., 271: 610-15(Sept. 17, 1964).

Use of total-body ionizing irradiation to suppress the immunologic response of the host to homografted tissue is reviewed. When nonreproducing antigens are given as a primary antigenic challenge within 40 hr of irradiation, maximum inhibition of antibody formation is observed, indicating that the preinduction phase of antibody evocation is highly radiosensitive. Once the capacity to synthesize antibody had been initiated, irradiation had little effect on subsequent antibody production. The concept of the radiation chimera is discussed, and methods involved in the production of radiation chimeras are considered. Although various factors are involved, it seems that immediate injection of cells after irradiation provides the best possibility for the rapid function of a transferred hematopoietic tissue graft. The problem of analysis of irradiation chimeras in terms of donor and host hematopoietic function, which revolves chiefly about the question of identification of cell genotypes in mixed populations, is examined. Some of the factors involved in determining the period of persistence of donor cells in an irradiated recipient are discussed. The delayed mortality of irradiated hosts after hematopoietic-tissue replacement, variously referred to as secondary disease, homologous or heterologous disease, bone-marrow disease, and the wasting syndrome, is considered. There is general agreement that the wasting syndrome is fundamentally dependent upon an immunologic reaction, since it occurs only in the presence of antigenic differences between host and donor. Very little evidence exists that the immunologic reaction involved is of the host-vs-graft type, and more evidence has been accumulated to suggest that it is based upon a graft-vs-host reaction. (BBB)

105 ACUTE RADIATION DEATH OF MICE WITH MASSIVE TOTAL BODY IRRADIATION WITH ^{60}Co GAMMA RAYS. Fujii, Kyoichi (Kyushu Univ., Japan). Nippon Acta Radiol., 25: 30-46(Apr. 1965). (In Japanese).

Studies were done with massive radiation dose rate of 30,000 R/min and 15,000 R/min of ^{60}Co gamma rays in mice. Time of death during irradiation was obtained from electrocardiogram analysis. From the observation of survival time after irradiation of various doses, the following experimental formula was obtained: $Ts = 660 \exp(-0.097\ D)$ (hr) for the dose rate of 30,000 R where D was doses in kR. The gradient coefficient of the formula was 15% steeper than that of the formula with the dose rate of 8,000 R/min reported in 1963. The total dose to death of mice during irradiation increased 20% at 30,000 R/min by injecting Contomin. Two different types of reactions to massive radiation were found. The first type consisted of an acute ataxic phase, a lethargic inactive phase, a false hyperactive convulsive phase, and true hyperactive convulsive phase. The reaction was observed in mice receiving less than 60,000 R. The second type consisted of a lethargic inactive phase and a hyperactive convulsive phase. The latter reaction was observed in mice receiving more than 60,000 R. An initial pitching phenomena of the base line of the electrocardiogram was observed. The total doses of the two groups were quite identical. Applying these values to the formula $Ts = 660 \exp(-0.097\ D)$, the survival time became about 4.8 days and it seems to coincide with 3.5 days effect reported by Rajewsky on the intestinal death of irradiated mice. Brain, lung, heart, liver, spleen, small intestine, adrenal glands, ovary, and kidney were examined histopathologically. Many small bleeding lesions were found in the brain. And some substances like glycogen granules disappeared in the liver cell, and endothelial cells of central artery of the spleen were slightly vacuolated. Severe congestions were demonstrated in all organs examined except the small intestine. However, these changes did not explain the cause of acute radiation death. (auth)

106 RADIATION IN PERSPECTIVE. Nucl. Safety, 5: No. 3, 226-8(Spring 1964).

A discussion of the impact of radiation on society is presented. Aspects of the potential hazard from radiation are discussed, and mutagens affecting the genetic material at

concentrations which cause cellular damage are tabulated. (J.R.D.)

107 CONTRIBUTION TO THE RADIOBIOLOGICAL BASIS OF THE MAXIMUM PERMISSIBLE RADIATION DOSE. Zimmer, K. G. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 7: 380-3(Aug. 1965). (In German).

The irregular rise of mutation frequency with x-ray dose observed when testing gametes after irradiation at different stages of development is shown to average out to a linear rise for a population of gametes comprising many stages. Consequently, the experiments lend further support to the generally accepted view that maximum permissible doses have to be fixed assuming a linear rise of mutation frequency and complete absence of a threshold dose. Elastic nuclear collisions produced by protons of less than 1 kev are demonstrated to cause damage in the biologically important enzyme ribonuclease. In fact, the probability of inactivation is four times larger for elastic nuclear collisions than for ionizations. The results indicate that calculations or measurements of ionization may be inadequate for assessing the risk of damage by very slow protons and, consequently, for setting maximal permissible doses for epithermal neutrons. (auth)

108 BIOCHEMICAL LESIONS INDUCED IN SUBCELLULAR STRUCTURES BY IONIZING RADIATION. I. THIOL CONTENT OF RAT LIVER AND SPLEEN. Dancewicz, Antoni M. (Inst. of Nuclear Research, Warsaw). Nukleonika, 10: 207-12(1965).

The content of free thiol groups in subcellular fractions isolated from rat liver and spleen were determined 0.2 and 24 hours after whole-body irradiation of rats with a dose of 750 R. An increase in the thiols of nuclear fractions was found, while in other fractions a decrease or no change occurred. The change in thiol content of spleen preparations appeared immediately after exposure and persisted for 24 hours at least, whereas that of liver preparations was detectable only 2 hours after exposure. (auth)

109 A COMPARISON OF SOME POSSIBLE INDICES OF SEEDLING VIGOR IN CORN. Woodstock, Lowell A.; Combs, Michael F. (Agricultural Research Service, Beltsville, Md.). Proc. Assoc. Office Seed Analysts, 54: 50-60(1965).

Experiments were performed to determine whether the growth of corn (Zea mays) seedlings during early stages of germination can be used to predict subsequent growth when both initial and later conditions are conducive to rapid germination and growth. Presowing irradiation of seed at different doses provided a range of seedling vigor. The rates of irradiated seedling growth in an incubator between 2 and 5 days after planting were compared with shoot emergence and subsequent growth, over a two-week period, of seeds planted in the greenhouse. The seeds were irradiated with ^{60}Co γ rays at doses of 0, 5, 10, 20, 40, and 80 krad at a dose rate of 5000 rad/min, dried to 10.7% moisture content, and stored in plastic bags at 22 ± 2°C. Seeds were germinated in darkness on moist paper towels at 25°C and 95% relative humidity. Doses of 5 and 10 krad did not inhibit seedling growth, but 20 krad inhibited growth. The 40- and 80-krad doses were markedly inhibiting, the latter usually preventing emergence of the seedling above the soil. Irradiation did not affect the uniformity of growth except at the highest two doses where an increase in the coefficients of variation was due to the failure of many shoots to emerge at these doses. The relatively high coefficients during the first few days after shoot emergence could be ascribed to the same factor. The data were used in a variety of calculations designed to evaluate the greenhouse performance relative to the controls of the seeds damaged to various extents by the irradiation treatments. Thus, various indices based on increases in length of the root, shoot, and embryo axis, and on seedling fresh weight, were compared for potential value in predicting growth. Of the criteria investigated, shoot growth provided the best basis for predicting subsequent seedling performance. The results therefore indicate that the growth of corn seedlings during the first few days of germination in an incubator under favorable conditions can provide the basis for predicting seedling growth in the greenhouse up to two weeks under favorable conditions. However, it is emphasized that only γ-irradiation treatments were used to provide a range of vigor, and it cannot be assumed that the nature of the relation between early and later seedling growth would be the same here as in other kinds of seed injury. (BBB)

110 IONIZING RADIATION, ATHEROSCLEROSIS, AND LIPID METABOLISM IN PIGEONS. Artom, Camillo; Lofland, Hugh B. Jr.; Clarkson, Thomas B. (Wake Forest Coll., Winston-Salem, N. C.). Radiat. Res., 26: 165-77 (Oct. 1965).

Long-range effects of repeated doses of ionizing radiations (x irradiation or, in a small number of experiments, internal radiation by ^{32}P) were studied in two breeds of pigeons, White Carneaux and Show Racers, exhibiting a high or a low degree, respectively, of susceptibility to aortic atherosclerosis. Both breeds appear to be remarkably radioresistant, a sizable mortality having been observed only after cumulative doses between 2000 and 6500 R, given in ten to fourteen sessions at 2-week intervals. No increases in the prevalence or the severity of aortic disease were demonstrable in irradiated White Carneaux fed either cholesterol-free or cholesterol-supplemented diets, or in Show Racers fed a cholesterol-free diet. However, 10 to 13 months after the irradiation sessions with high doses of x rays had been started, Show Racers on a 1% cholesterol diet exhibited more aortic lesions than the corresponding nonirradiated controls. At the same time intervals and also after large cumulative doses of x radiation, the prevalence and the severity of coronary atherosclerosis were found to be increased in White Carneaux maintained on a 0.1% cholesterol diet. No consistent long-range effects of x irradiation could be detected on the levels of serum lipids, or on certain processes of lipid metabolism (formation of liver lecithin by transmethylation from methionine methyl-^{14}C, and biosynthesis of lipids from acetate-1-^{14}C in liver slices). The finding of an increased rate of lipid synthesis in the perfused aortas of some of the irradiated pigeons is believed to be related to the greater severity and extension of the lesions and should therefore be regarded as an indirect effect of x irradiation. (auth)

111 EARLY EFFECTS OF X-IRRADIATION ON THE ULTRASTRUCTURE OF GASTRIC FUNDUS GLANDS. Helander, Herbert F. (Univ. of Gothenburg, Sweden). Radiat. Res., 26: 244-62(Oct. 1965).

The gastric fundus glands of irradiated mice were examined electron microscopically. The animals were given a whole-body dose of 1340 R. Specimens were taken from the gastric mucosa of animals sacrificed ½, 3, 6, 9, 12, 24, 36, and 48 hours after the irradiation. In the irradiated animals the α-cytomembranes of the zymogen cells were much more irregularly disposed than in the normal animals. The surface membrane of the zymogen granules was often broken, and their content was less dense than usual. The diameter of the mitochondria was increased by approximately 25% 24 hours after the irradiation, but returned to a normal value after 48 hours. In a few cases binucleate zymogen cells were observed. The parietal cells often bulged into the gland lumen. The diameter of the mitochondria was increased to about the same extent as in the zymogen cells. The vacuoles were sometimes distorted. In the mucoid cells the diameter of the secretory granules was increased by approximately 80% 24 hours after irradiation. The mucoid cell nucleus exhibited a varying number of inclusion bodies, presumably of a cytoplasmic origin. Rarely were giant nuclei encountered. (auth)

112 SERUM LACTIC DEHYDROGENASE LEVELS IN ADULT BEAGLE DOGS WITH INTERNALLY DEPOSITED RADIONUCLIDES. Ruhmann, Ann G.; Berliner, David L. (Univ. of Utah, Salt Lake City). Radiat. Res., 26: 287-94 (Oct. 1965).

Serum lactic dehydrogenase determinations, performed on 110 beagles from a colony used in the study of long-

term effects of internally deposited radionuclides, revealed a mean LDH level of 22.8 units. Dogs receiving high doses of radiation had blood LDH levels significantly higher than those of control dogs. Animals having osteogenic sarcomas and other pathologic states had normal LDH levels. Statistical analysis revealed no significant differences among groups separated by radioisotope or time elapsed after nuclide was injected. Sera from moderately hemolyzed samples were significantly higher in LDH level than sera from non-hemolyzed or slightly hemolyzed blood samples. It was concluded that serum LDH level is correlated with level of internal irradiation but is not a consistent indicator of pathologic states in irradiated dogs. (auth)

113 THE EFFECT OF THICKNESS ON THE CENTRAL BEAM DOSE RECEIVED BY A BEAGLE EXPOSED TO 1000-Kvp X-RAYS. Maillie, H. David; Mermagen, Herbert (Univ. of Rochester, N. Y.). Radiat. Res., 26: 295-304(Oct. 1965).

Data are presented for expressing the midline dose, along a 1000-kvp x-ray beam center, in terms of a known midline air dose. It is also felt that results of lethality experiments previously reported indicate that the thicker (or heavier) dogs fare better when exposed to a given midline air dose. (auth)

114 A SEARCH FOR MECHANISMS OF RADIATION RESISTANCE IN POCKET MICE. Gambino, Jerome J.; Lindberg, Robert G.; Hayden, Page (Northrop Space Labs., Hawthorne, Calif.). Radiat. Res., 26: 305-17(Oct. 1965).

In a series of experiments designed to elucidate the role of hypoxia in radiation resistance of Perognathus, several groups of P. longimembris were subjected to ^{60}Co irradiation under various conditions. One group was administered 100% oxygen at 3 atm during irradiation. Another was splenectomized prior to irradiation. These two groups received a whole-body dose of 1400 Rads. A third group was administered 2100 rads while in severe hypoxia. Results suggest that hypoxia mechanisms are not responsible for the remarkable radiation resistance of Perognathus. Effects of body temperature on radiation response were tested in two ways. Animals were administered 1400 Rads and were forced to maintain normal active body temperature during the entire 30-day postirradiation period. Others were administered 1700 Rads while hypometabolic (body temperature 9°C). Postirradiation survival in pocket mice was not significantly altered by changes in metabolic processes either during or after irradiation. Pocket mice were exposed to massive ^{60}Co irradiation: 8.5, 13.7, or 24.1 kRads. Animals receiving the 8.5- or 13.7-kRad doses died in 5 to 11 days. Those administered 24.1 kRads died within 1 day. Radiation resistance in pocket mice appears to be related to unusual capabilities within specific regenerative systems, rather than to physiological processes related to their ability to undergo hypothermia. (auth)

115 BIOCHEMICAL EXPONENTS OF RADIOSENSITIVITY OF CENTRAL NERVOUS SYSTEM. Cherkasova, L. S.; Koldobskaja, F. D.; Kuhushkina, V. A.; Mironova, T. M.; Pikulev, A. T.; Remberger, V. G.; Silyaeva, M. F.; Taits, M. U.; Fomichenko, K. V.; Khripchenko, I. P. (Inst. of Physiology, Academy of Sciences, Minsk, BSSR). Radiobiol. Radiotherap. 6: 395-404(1965).

Radioinduced changes in protein and carbohydrate metabolism observed in brains irradiated with small doses of neutrons or x rays were determined to be evidence of central nervous system radiosensitivity. (H.G.D.)

116 THE EFFECTIVENESS OF PARTICULAR HEMATOLOGICAL CRITERIA FOR JUDGING RADIATION EXPOSURE. Morczek, A. (Strahlentherapeutische Klinik, Magdeburg, Ger.). Radiobiol. Radiotherap. 6: 421-8(1965). (In German).

Changes in the blood-picture belong to the most sensitive criteria of radiation exposure. Various elements of blood show very great differences in sensitivity and constancy of reaction to irradiation. On the basis of experimental findings in animal, serial and clinical examinations of irradiated persons are analyzed. (TCO)

117 ROENTGEN-INDUCED RADIATION INJURY OF THE RETINA IN NEW-BORN MICE. Fischer, H. (Humboldt-Universitaet, Berlin). Radiobiol. Radiotherap. 6: 439-45(1965). (In German).

The radioinduced injury of the retina in newborn mice is based on the destruction of the granular layer capable of division. In the wake of injury the layer of ganglion cells considered as being resistant will be destroyed. Rosettes are not to be found in the typical enlarged form. Their formation is obviously dependent on the state of maturity of the outer granular layer. The transformation of outer granules into cells with runners that push a hole through the membrana limitans externa is considered as radiation-induced precocity towards the formation of abortive rods. (auth)

118 A COMPARISON OF THE EFFECT OF MITOMEN AND X RAYS ON ASCITES CELLS OF EHRLICH CARCINOMA IN MICE. Becker, H.-D.; Strassner, W.; Fischer, H. (Humboldt-Universitaet, Berlin). Radiobiol. Radiotherap. 6: 467-75(1965). (In German).

The effects of x radiation and the radiomimetic drug mitomen were compared in Ehrlich ascites cells of mouse carcinomas. Parameters studied were: mitotic inhibition, lethal doses, and pathologic mitoses. Results indicated that effect equivalence of radiations and radiomimetics in one parameter does not infer equivalence in others. (H.G.D.)

119 THE EFFECT OF HYPERICIN AS A SENSITIZER OF BIOLOGICAL SYSTEMS IN COMPARISON WITH OPTICAL AND IONIZING RADIATIONS. Rose, H.; Wagner, H. (Humboldt-Universitaet, Berlin). Radiobiol. Radiotherap. 6: 477-83(1965). (In German).

Reasons for the ineffectiveness of Hypericin as a radiosensitizer in biological systems exposed to ionizing radiation are discussed. It is suggested that sensitization is produced by radioinduced toxic substances. Since the interaction of radiations and sensitizer molecules is required for a radiosensitivity effect, the number and distribution of such molecules become determining factors. Biological systems are damaged by sensitizer substitution in DNA. (H.G.D.)

120 THE EFFECT OF CHRONIC IRRADIATION WITH LOW DOSE-RATE ON PLANTS AND THEIR PHOTOREACTIVABILITY. Brucker, W. (Ernst-Moritz-Arndt-Universitaet, Greifswald, Ger.). Radiobiol. Radiotherap. 6: 485-90(1965). (In German).

The different effects between a chronic irradiation with low dose-rate and an acute irradiation with high dose-rate of plants were examined by studying the metabolism of phosphate and nucleic acid in the stems of tomato plants and in vitro cultures of carrot tissue. Distinction was made between ortho-phosphate and organically bound acid-soluble and acid-insoluble phosphates. DNA-contents were separately determined. A gamma irradiation in darkness for 14 days with a total of 5 kR (dose-rate 15 R/h) led to a rapid increase of 30% of the ortho-P content. The DNA-content was reduced by one third. In order to obtain a corresponding effect (14 days after irradiation) after an acute x-irradiation (250 kv, HVL 1.2 mm of Cu) with high dose-rate (60 R/h) administration of 45 kR was necessary. If after gamma irradiation with low dose-rate the plants or tissues were exposed to fluorescent tubes of 1000 and 5000 Lux, respectively, for 8 to 10 hours, the radiogenic effect on the contents of ortho-P and DNA practically failed to appear. The same exposure of plants or tissues acutely x-irradiated with high dose-rate for 10 hours or 14 days after irradiation did not influence the extent of the observed radiogenic effect. (auth)

121 THE EFFECTS OF RADIATION ON MAMMALIAN CELLS. Looney, William B. (Univ. of Virginia School of Medicine, Charlottesville). Radiol. Clin. N. Am., 209-17(Aug. 1965). (TID-21854).

Evidence relating cell injury or death by ionizing radiation to impairment of DNA synthesis of mammalian cells is reviewed. Most of the results considered were obtained in irradiated hepatectomized rats. (TCO)

122 SPACE REPORT. EXTRATERRESTRIAL RADIATIONS. I. BIOLOGICAL STUDIES. Delahaye, R. P.; Tabusse, E. (Centre d'Etude et de Recherches de Medecine Aeronautiques, Paris). Rev. Med. Aeron. (Paris), 3: 593-7(Jan.-Feb. 1964). (In French).

The authors review the findings and results of biological studies which bear upon the biological effects of extraterrestrial radiations. The four types of extraterrestrial radiations include galactic cosmic radiations, solar cosmic radiations, radiation of the Van Allen belt, and interplanetary plasma. The composition of these radiation areas is relatively well known, but too frequently results of studies of their effects on biological materials, animals, and plants is unexact or even contradictory. Sources from which estimates of probable radiation effects can be drawn include studies made on, or under, the surface of the earth itself, during flights in planes, balloons, and satellites. A wide variety of experimental animals and plants have been tested for radiobiological effects. These include mammals such as dogs, guinea pigs, rats, and pigs, drosophila, grains and vegetables, chlorella, microbiological samples, and DNA. Estimates of the relative biological effectiveness of radiations encountered have been made. Many of these measurements have been made below sea level, as well as at sea level, during balloon flights, or in satellites. Observations made in humans are rare, but there has been no evidence of radiation effects in the few persons observed. Cosmonauts are reported to have received doses less than 100 or 150 Mrad, depending on the relative duration of the flights. (BBB)

123 ACTUAL THOROTRAST PROBLEM: A LIVER SARCOMA WITH INTRAPERITONEAL BLEEDING. Wenz, Werner; Ott, Gerhard (Universitaet, Heidelberg). Strahlentherapie, 127: 463-9(July 1965). (In German).

Fifty-seven out of 110 published thorotrast tumors were found to be in the liver; 20 of those were hemangioendotheliomas. Another case of malignant hemangioendothelioma of the liver is reported in a 59 year old patient. This tumor developed after a severe thorotrast cirrhosis 27 years after femoral-arteriography. The cause of a severe intra-abdominal bleeding could be determined only after laparotomy. The bleeding was caused by the liver tumor; repeated hemorrhaging resulted in death. (auth)

124 STUDIES ON THE DEVELOPMENT OF IMPROVED STRAINS OF STREPTOMYCES CITREUS THROUGH INDUCED MUTATION. Naha, P. M.; Nandi, P. Trans. Bose Res. Inst. (Calcutta), 26: 97-105(Sept. 1963).

Different doses of ultraviolet and gamma radiations were administered to Streptomyces citreus with a view to obtain better antibiotic-producing mutants. Some of the mutants obtained through γ irradiation only showed higher titre values; the isolates of the uv irradiated strains were not promising and therefore not selected for further experiments. Four strains, namely M-88, M-1017, M-1038, and M-2042, were preliminarily selected for detailed study as all of them showed higher antibiotic yield. Of these, M-1017 was finally selected for large-scale production of the antibiotic in submerged culture because this strain remained stable through successive generations. (auth)

125 CLINICAL PROBLEMS OF KIDNEY TRANSPLANTATION IN HUMANS. Brosig, W.; Nagel, R. (Freie Univ., Berlin). Urologe, 4: 1-8(Jan. 1965). (In German).

Use of ionizing radiation and other immunosuppressive agents in preventing the homograft reaction is discussed, and the detailed case histories of five patients who underwent renal transplantation, some of whom received radiation treatment, are outlined. Two patients were given 150 R one day prior to transplantation, and in one case the transplanted kidney was ^{60}Co irradiated (600 R), when the rejection reaction developed several months later. A survey shows that from 1954 to 1963 about 152 transplantations were performed, but from 1963 to 1964 222 were carried out. Out of all 374, of which 17 were secondary transplants, 108 patients were alive in March 1964, of whom 67 had lived longer than 6 months postoperatively. The effectiveness of preoperative treatment with Imuran, actinomycin C, and corticosteroids, as well as several 150-R doses of radiation to the transplanted kidney when the homograft rejection reaction develops, was verified. (TCO)

126 INACTIVATION OF SOUTHERN BEAN MOSAIC VIRUS BY ULTRAVIOLET LIGHT. Price, W. C. (Univ. of Florida, Gainesville). Virology, 25: 1-8(Jan. 1965).

Investigation of the effects of radiation on Southern bean mosaic virus (SBMV), a virus with an essentially spherical particle and a dia of about 25 mμ, was conducted as a means for knowledge about the mechanism of action of radiation. Rates of inactivation of SBMV by radiation of wavelength 253.7 mμ and photoreactivation of partially inactivated virus were studied. Inactivation of SBMV by uv light followed a simple exponential survival curve equivalent to the course of a first-order reaction. Inactivation could be expressed by the equation: $\log (C/C_0) = kt$, in which C_0 is the initial concentration, C the concentration after exposure for time t, and k the reaction velocity constant. Under the conditions of the experiments, inactivation of SBMV by uv light is represented by the equation: $\log C/C_0 = -0.159 \pm 0.010$ min^{-1}. In experiments carried out to determine whether or not irradiated SBMV could be photoreactivated, survival was lower for irradiated virus in plants kept for a few hours in the dark than for the same samples when they were assayed on plants kept in the light immediately after inoculation. The rate of survival when samples were assayed on plants kept in the light gave a value of $\log C/C_0 = -0.246 \pm 0.028$ min^{-1}, compared with $\log C/C_0 = -0.159 \pm 0.010$ min^{-1} for assay plants kept in the light. The difference between the two velocity constants is highly significant, and was interpreted to mean that SBMV inactivated by exposure to uv light can be partially photoreactivated after assay plants are inoculated with it. The intensity of the radiation absorbed increased greatly as the concentration of virus was increased from 0.1 to 0.5 mg/ml and somewhat less rapidly as the concentration was increased from 0.5 to 2.0 mg/ml. The quantum yield for inactivation of SBMV was calculated to be 2.25×10^{-5}, which is about $1/10$ that for tobacco mosaic virus. This value indicates that many quanta are absorbed by a particle of SBMV before it is inactivated. The RNA, which presumably is the active part of the virus, makes up 21% of the SBMV particle. Even if only 21% of the quanta absorbed are absorbed by the RNA fraction, there would still be about 9000 quanta absorbed by the RNA for each particle that is inactivated. (BBB)

127 INDIRECT ULTRAVIOLET INDUCTION OF PROPHAGE λ AND COLICIN I FACTOR. Devoret, R.; Monk, M.; George, J. (Centre National de la Recherche Scientific, Gif-sur-Yvette, France). Zentr. Bakteriol. Parasitenk., Abt. I. Orig., 196: 193-207(1965).

To investigate the mechanism of uv induction of prophage λ in Escherichia coli K12, properties of such a transmissible uv inducer were studied. To avoid confusion with zygotic induction, also frequently designated as induction by conjugation, the term indirect uv induction (IUI) is used as opposed to direct uv induction which occurs when lysogenic bacteria are directly exposed to uv light. Some data concerning IUI obtained through the use of colicin I factor as well as by transfer of the F factor, are compared. It was shown that episomes as prophage λ, prophage 434, or colicin I factor present in a recipient cell can be induced as a consequence of conjugation with an uv-irradiated donor cell. This phenomenon (IUI) can occur in F or colicin I mediated conjugation, but not when the F factor is integrated into the bacterial chromosome as in the case of a Hfr $\times$ F$^-$ cross. Positive results were also obtained when the sex factor was not directly exposed to uv light. Thus, an extrachromosomal labile determinant, nonspecific for any inducible episome, is responsible for IUI. This determinant is probably composed of DNA, as suggested by experiments in which host-cell reactivating deficient bacterial mutants were used. A plausible explanation to account for indirect induction is to assume that IUI is caused by the sex factor itself or by some DNA material which can be transiently associated with it. Alternative hypotheses are that the factor is a distinct replicon transmitted by a sex factor, or that it is a cytoplasmic constituent. The latter hypothesis implies that bacterial conjugation would

provide a means to detect the transfer of a cytoplasmic inducer from cell to cell, but further assumptions concerning the mechanics of conjugation would be required to explain the failure of indirect induction through chromosomal transfer. (BBB)

128 ON THE PROBLEM OF EARLY DIAGNOSIS OF ACUTE RADIATION SICKNESS IN DOMESTIC ANIMALS. Zicha, B.; Pospisil, J. (Inst. for Veterinary Research, Prague). Zentr. Veterinaermed., 12: 355-64 (1965). (In German).

Demonstration of the degradation products of deoxyribonucleic acid in urine was performed for the diagnosis of early irradiation effects. Adult female pigs or sheep given whole-body irradiation by a ^{60}Co source. The effective dose rate administered was 5 R/min. In pigs that each received a total of 600 R, excretion of deoxyribosides in urine reached a max value at 6 hr postirradiation. In pigs that received 300 R of whole-body irradiation there was no detectable excretion of deoxyribosides in urine. In sheep that had been irradiated with 600 R or with 200 R of whole-body irradiation the excretion of deoxyribosides attained a max at 6 hr postirradiation. By the 24-hr time interval excretion of these substances was back to a zero value in the animals that received 200 R. In the animals that received 600 R the increased excretion was not proportional to the increased irradiation dose, but the time required before the urinary excretion of deoxyribosides returned to a zero value was extended to as long as 6 days after irradiation. The appearance of deoxyribosides in urine of pigs and sheep after irradiation seems to be an all or nothing reaction, and probably results from degradation products of radiosensitive cells. It is a sensitive test for diagnosis of radiation sickness during the early postirradiation period. For later periods this test is not as valuable as more classical, hematological diagnosis. (BBB)

129 UV-INACTIVATION, PHOTOREACTIVATION AND THE DECAY OF PHOTOREACTIVABILITY OF THE GREEN-COLONY-FORMING SYSTEM OF EUGLENA GRACILIS (thesis). Hill, Helene Z. Waltham, Mass., Brandeis Univ., 1964. 258p.

Ultraviolet inactivation, photoreactivation, and decay of photoreactivability of green colony formation in Euglena gracilis var. bacillaris were studied using conventional radiobiological techniques. Ultraviolet inactivation proceeds in an exponential manner following an initial lag. Light-grown, dark-grown light-adapting, and mutant cells give inactivation curves that are parametrically related, but the difference in sensitivity of the various kinds of cell cannot be correlated with chlorophyll content. Curves predicted by target theory fit the data, and the multiplicity of the curves indicates there are about 30 to 40 uv-sensitive centers controlling green colony formation. Photoreactivation is sensitive to temperature and other environmental conditions, suggesting that enzymatic processes are involved, and the reciprocity rule applies over a 6-fold range of intensity. The kinetics of photoreactivation vary with the uv dose. The decay of photoreactivability is exponential after an initial lag, and decay does not occur in resting medium but can occur prior to cell division in a nutrient medium. The kinetics of decay vary with the uv dose in a complex way. The rate of decay appears to be directly proportional to the generation time of the cells, the shorter the generation time, the more rapid the decay. The uv sensitivity of uv-inactivated photoreactivated cells, both before and during decay, is the same as that of unpretreated cells. The kinetics of photoreactivation of decaying cells exhibit an apparent decrease in multiplicity with time and a corresponding decrease in rate. The kinetics of photoreactivation of resting cells do not change, but the rate is variable and depends on the previous history of the cells. A model is presented to explain some of the results. (A.G.W.)

Radiation Effects Therapy and Countermeasures

130 STUDIES ON CHEMICAL PROTECTION FROM IONIZING RADIATION. III. DYNAMICS OF HEMATOLOGIC CHANGES IN MICE TREATED WITH SODIUM CYSTEINETHIOSULFONATE BEFORE IRRADIATION WITH LARGE DOSES OF X-RAYS. Zebro, Tadeusz; Stachura, Jerzy; Prochnicka, Barbara; Szczepkowski, Tadeusz (Medical Academy, Krakow). Acta Med. Polona, 6: 155-69(1965).

About 30 to 40% of mice survive the acute stage of postradiation disease following exposure to lethal doses of x rays (700 R) if sodium cysteinethiosulfonate (CTS) is first injected intraperitoneally. A protective action of the compound was observed also after irradiation with 850 and 520 R of x rays. Compared with other compounds which protect from ionizing radiation, CTS is relatively safe. Its lethal toxic dose is several times higher than doses exhibiting protective action. To investigate the mechanism of the protective action of CTS, morphologic changes in the peripheral blood and bone marrow were examined in groups of 500-R x-irradiated mice treated with 5 mg CTS/10 g body weight five min before exposure. (TCO)

131 STUDIES ON CHEMICAL PROTECTION FROM IONIZING RADIATION. IV. THE INFLUENCE OF SODIUM CYSTEINETHIOSULFONATE ON THE RESULTS OF X-RAY TREATMENT OF TRANSPLANTABLE CROCKER SARCOMA. Zebro, Tadeusz; Jorasz, Elzbieta; Szczepkowski, Tadeusz; Stachura, Jerzy; Niezabitowski, Aleksander (Medical Academy, Krakow). Acta Med. Polona, 6: 171-7(1965).

Mice with transplantable Crocker sarcoma were irradiated locally at intervals of 24 hr with 300 R of x rays for 13 days (total dose of radiation 3900 R). One group of the mice received intraperitoneal injections of sodium cysteinethiosulfonate (CTS) before irradiation. CTS exerted a certain degree of protective action on the irradiated tumor tissue, diminishing the effect of roentgentherapy of Crocker sarcoma in mice. After irradiation the rate of growth of the tumors diminished, and the dimensions decreased by 30% compared with the dimensions before irradiation in male mice. The rate of growth of the tumors in male mice which received injections of CTS was slower than in the control group, but faster than in the irradiated mice. After 18 days the dimensions of the tumors attained 1250% of the starting values. The growth of the tumors differed in female mice, compared with males. Tumors in female mice which were only irradiated and those which were irradiated after injection of CTS were distinctly smaller than in unirradiated female mice. Tumors in irradiated male mice were distinctly smaller than in the unirradiated male mice. The smallest tumors were found in male mice which were only irradiated. Significantly larger tumors were observed in the group which was irradiated after injection of CTS. The differences between each mean volume of the tumors are greater than the double standard error of the differences of the means. In the female mice the dimensions of the tumors were smaller in the irradiated group than in the control group and in the group which only received injections of CTS. (BBB)

132 TRIPROLIDINE AND THE RESPONSE OF SKIN TO ULTRA-VIOLET RADIATION. Lloyd, Jennifer; Johnson, B. E. (St. John's Hospital for Diseases of the Skin, London). Brit. J. Dermatol., 77: 244-8(May 1965).

Previous reports indicate that triprolidine-HCl (Actidil, Pro-Actidil) will abolish the abnormal responses to sunlight on photosensitive patients and reduce significantly the sunburn reaction in normal subjects. These observations are potentially of great importance for it may be that an agent which suppresses the acute effects of uv radiation in the skin may be capable of preventing the chronic effects, especially neoplasia. Studies were made of acute effects of uv on the skin of subjects treated with triprolidine by (1) examining the normal erythemal response with and without the drug in humans and mice; (2) seeking alteration by the drug of pathological responses in patients abnormally photosensitive, and (3) assaying the protection afforded by topical triprolidine of human skin. Oral treatment with triprolidine in ordinary dose had no effect on normal erythema whether elicited by monochromatic uv radiation of 300 mμ or by mixed radiation closely similar to midday summer sunlight. With relatively much higher dosage of

triprolidine in mice, no modification of the response to 300 mμ could be detected. Topical applications demonstrated no screening effect. The responses to controlled testing of seven patients with polymorphous light eruption were also not significantly modified by triprolidine; the same result occurred in six patients who took the drug as outpatients. In two other patients with both solar urticaria and a papular type of reaction, the wealing response was reduced by this drug. Thus the results of these investigations into the possibility that triprolidine modifies normal and abnormal reactions to uv are inconclusive. No impressive therapeutic effects were seen. Triprolidine is probably no more than an effective antihistamine with probably less marked side effects than other preparations. The potential intraepidermal screening action of oral triprolidine by specific absorption of uv, as suggested previously, is shown by simple theoretical considerations to be unlikely. Even if the whole of an oral dose of 25 mg of the drug were to be selectively deposited in the epidermis, as suggested earlier, the increased optical density of the epidermis due to triprolidine was calculated to be negligible. If the average thickness of the epidermis is taken to be 100 μ and the skin area of a 70-kg male, 175-cm tall, to be 1.85 m^2, the optical density arising from triprolidine is only of the order of about 10^{-3}, which is insignificant. (BBB)

133 THE USE OF PRESERVED HEMATOPOIETIC TISSUES FOR TREATMENT OF MICE LETHALLY IRRADIATED WITH GAMMA RAYS UNDER HIGH DOSE RATE. I. EFFECT OF PRESERVED ISOLOGOUS BONE MARROW. Hama, Masaharu (Kyoto Univ.). Bull. Inst. Chem. Res. Kyoto Univ., 43: 64-93(Jan. 1965).

Mice were lethally irradiated with gamma-rays under high dose rate and were treated with preserved isologous bone marrow. The isologous bone marrow cells were suspended in 15% V/V glycerol-Tyrode's solution at −80°C as long as 450 days. As to the survival rate at 30 days after irradiation, the isologous bone marrow within 360 days preservation protected well the lethally gamma-irradiated mice as well as the fresh isologous bone marrow transplantation up to 5 million of nucleated cells were injected. (auth)

134 THE CLINICAL APPLICATION OF BONE MARROW GRAFTS. Newton, K. A.; Humble, J. G. (Westminster Hospital, London). Cancer Progr. (London), 184-9 (1963).

The use of bone marrow grafts to enhance the survival of irradiated animals is reviewed, along with pertinent clinical literature, and a description of technics for obtaining and preserving bone marrow cells is given. Clinical applications of infusion of marrow suspensions have included the administration of isologous cells to one of a pair of identical twins who developed leukemia. While the transfer of bone marrow from one twin to the other proved simple, eradication of the leukemic process from the diseased child did not. This procedure has been attempted on a number of occasions in different countries following the administration of whole-body irradiation. A well-known hazard of large volume irradiation is the subsequent lowering of both red and white cell counts. The natural process can be speeded up by re-infusing either the patient's stored marrow following completion of a course of large volume irradiation, or by the aspiration and redistribution of the patient's own marrow by the intravenous route. If use is made of autologous hemopoietic cells, the dose of large-volume irradiation is no longer governed by low peripheral white cell or platelet counts. However, hematological tolerance is not the sole factor, for tissue tolerance rapidly decreases when large volumes are homogeneously irradiated. Mouse leukemia can be irradicated by whole-body irradiation and subsequent homologous marrow infusion, which led to hope that human leukemia could be treated in a similar manner. Whole-body irradiation followed by intravenous infusion of marrow cells from single or multiple donors has now been attempted in many centers, the results of which are described. (TCO)

135 FREEZING OF BONE MARROW FOR CLINICAL USE. Pegg, D. E. (Westminster Hospital, London). Cryobiology, 1: 64-71(Sept.-Oct. 1964).

Methods for collection, preservation, viability testing, and infusion of human bone marrow, for use in subjects who have received heavy doses of radiation or cytotoxic drugs, are described. Dimethyl sulfoxide (DMSO) is probably the most effective additive for the preservation of mouse bone marrow. When survival rate of irradiated mice given glycerol-preserved marrow was compared with DMSO-preserved marrow, there was a slightly more rapid peripheral blood recovery in the latter group. In deciding between these two agents, the obnoxious odor emitted by persons injected with DMSO must be considered, and there is evidence that DMSO is more toxic than glycerol. In freezing techniques, great importance has been attached to the use of slow cooling to −79°C. The marrow containers are cooled in a bath of ethanol, the temperature of which is lowered by the controlled intermittent injection of ethanol at −70°C. Since −79°C is not sufficiently low for long-term preservation, a liquid nitrogen refrigerator with storage temperatures of −140 to −196°C is preferred. Thawing by continuous gentle agitation in a well-stirred 40°C water bath is recommended. In clinical use the freshly thawed marrow is injected slowly via intravenous infusion. Complications are described. In 53 infusions, side-effects attributable to the marrow infusion occurred in 14. (TCO)

136 THE EFFECT OF HOMOLOGOUS LIVER, THYMUS AND SPLEEN DNA ON THE SURVIVAL AND RECOVERY OF FERTILITY OF MALE RATS IRRADIATED WITH A DOSE OF 600 r DURING THE INFANTILE PERIOD AND CHANGES IN THE FIRST GENERATION. Savkovic, N. V.; Hajdukovic, S. I. (Inst. of Nuclear Sciences Boris Kidrich, Belgrade). Int. J. Radiat. Biol., 9: 361-8(1965).

A study was made of the effect of DNA extracts from homologous liver, thymus, and spleen on the survival and recovery of fertility of male rats irradiated in the infantile period with a dose of 600 R. The results shows that rats 17 days old, irradiated and treated with homologous DNA extracted from liver, thymus, and spleen, survive radiation disease. A study of fertility showed that DNA isolated from the organs mentioned above is able to recover the function of the reproductive organs of male rats. Malformations of the progeny in the first generation were investigated in all these experiments. (auth)

137 FURTHER INVESTIGATIONS INTO THE PROTECTION OF AQUEOUS POLYMER SOLUTIONS BY COLLOIDAL SULPHUR. Kopp, P. M.; Charlesby, A. (Royal Military Coll. of Science, Swindon, Eng.). Int. J. Radiat. Biol., 9: 383-9(1965).

Low concentrations of colloidal sulfur can act as very efficient radiation protecting agents in solutions of polymers and biological materials (enzymes). A large amount of protection is offered where an indirect effect operates; a much smaller amount of protection being offered against direct action. An investigation was made into the nature of the protecting mechanisms using a labeled colloidal sulfur suspension and tritiated water to distinguish between true repair and stabilization repair reactions. (auth)

138 GENETIC FACTORS INFLUENCING IRRADIATION PROTECTION BY BONE MARROW. V. MULTIPLE ALLOGENEIC DONORS. Uphoff, Delta E.; Press, Louisa P.; Lieberman, Rose (National Cancer Inst.; Bethesda, Md.; National Inst. of Allergy and Infectious Diseases, Bethesda, Md.). J. Nat. Cancer Inst., 35: 695-705(Oct. 1965).

Under certain conditions, lethally irradiated strain A mice were protected against acute irradiation death by a marrow pool from several allogeneic donors without an increase of the total inoculum. The secondary disease syndrome was severe and lethal when the marrow pool consisted of only incompatible marrow. Addition of related hybrid marrow or H-2 compatible marrow to the pool decreased the severity of the syndrome. Survival was intermediate between that expected after the inoculation of the most compatible marrow and the least compatible marrow. Permanent marrow grafts, as indicated by acceptance of parental strain skin homografts and by presence of hybrid γ-globulin allotypes, were established with marrow from related F_1 hybrids and H-2 compatible hybrids. Permanent

skin homografts indicated mixed chimerism between related F_1 hybrid and incompatible hybrid marrow when one parent of each hybrid was compatible. The γ-globulin allotype data suggest the possibility of other mixed chimerism, but absence of permanent skin homograft of the appropriate phenotype indicates the necessity for further investigation of the correlation of γ-globulin allotypes and skin homograft acceptance, or rejection, or both. (auth)

139 ON SOME POSSIBILITIES OF PROTECTING CELLS FROM DAMAGING EFFECTS OF ULTRAVIOLET IRRADIATION. Levin, V. L. (Inst. of Cytology, Leningrad). Photochem. Photobiol., 3: 43-53(Mar. 1964).

Experiments were performed on the ciliated epithelium of the gills of the pearly mussel Unio crassus. The extent of damage of the frontal ciliated epithelium of control and uv-irradiated pieces was estimated by the quantity of the cells which kept mobile cilia. The irradiation was carried out with a BUV-15 bactericid lamp (80–90% of the irradiation energy at 2537 Å). Doses of irradiation on the order of 240–300 μw-min/cm² were used. Reparative processes are possible with these doses. Irradiated cells kept in the dark perish four times as fast as unirradiated cells, but if they are subjected to visible light immediately after irradiation, their survival time increases considerably. A decrease of the irradiation effect was observed if, before irradiation, pieces of gills had been kept in 0.25 to 0.5% $CaCl_2$ for 24 hr. Results were less effective when this period was increased up to 2 to 3 days. When the explants were kept 3 days in Dibazol, statistical differences in the condition of the irradiated cells were observed after this period, indicating Dibazol's prophylactic effect. With epithelium kept in saline solution and in a solution containing Dimezol before irradiation, after 7 days in the solution of Dimezol, resistance of the tissue to uv rays in a dose of 240 μw-min/cm² increased significantly. (BBB)

140 RADIOPROTECTION WITH AET-CYSTEINE IN THE RHESUS MONKEY. Melville, G. S. Jr.; Harrison, G. W. Jr.; Leffingwell, T. P. (Univ. of Texas, Austin; United States Air Force, Austin, Tex.). Radiat. Res., 26: 211-20(Oct. 1965).

A combination of radioprotective drugs, aminoethylisothiuronium dibromide (AET) and L-cysteine, was administered to Macaca mulatta monkeys prior to their receiving either 700 or 800 R of x radiation. Significant protection against mortality was observed at 700 R for animals given AET–cysteine intravenously, and for animals given AET–cysteine orally in conjunction with a sedative and postirradiation therapy. Protection was also observed at 800 R for animals given both AET–cysteine intravenously and postirradiation. Few differences in peripheral hematology were noted; however, changes in body weight and temperature were less pronounced in treated animals at 700 R than in untreated irradiates. (auth)

141 ABOUT THE CHANGE OF SUPRARENAL FUNCTION IN ACUTE RADIATION INJURY. David, G.; Faradi, L.; Tanka, D. (Ungarische Volksheeres und des Landesinstitutes fuer Rheumatologie und Balneologie, Budapest). Radiobiol. Radiotherap. 6: 405-12(1965). (In German).

The effects of AET on adrenal function were studied in irradiated rats. AET administered only: moderately increased the corticosterone content of the blood flowing off the suprarenal vein 120 hrs after the administration of AET; markedly stimulated the corticosterone-synthesizing function of the adrenal gland after 48 to 240 hrs post-irradiation; and did not change suprarenal structure histologically or histochemically. The lipoid content fluctuated toward the positive as to the negative side; but it is not proportional to the change of corticosterone emission. In irradiated rats that received 200 mg/kg AET intraperitoneally before irradiation and 100 mg/kg intraperitoneally 24 hours after irradiation: the corticosterone content of the blood flowing off the suprarenal vein significantly increased during the whole experiment (24 to 240 hrs) compared with the normal controls as well as with the irradiated untreated and with those receiving only AET; and the corticosterone-synthesizing function of the adrenal cortex of the irradiated animals in the group treated with AET differed from the untreated one as far as the initial increase of synthesis (24 hrs) was reduced. The increase of synthesis occurring after 24 hrs following AET failed to appear only in irradiated animals. (TCO)

142 THE LYMPHATIC REACTION FOLLOWING PARTIAL-BODY IRRADIATION. Klug, H. (Humboldt-Universitaet, Berlin). Radiobiol. Radiotherap. 6: 413-20 (1965). (In German).

Screening of spleen and adrenal glands did not appreciably affect the radiosensitivity of thymic lymphocytes, although thymic regeneration was accelerated. Latent effects evidently did not influence the radiation response in lymphocytes. The dose used did not change the lymphocytic reaction to corticosteroids. (TCO)

143 A STUDY OF THE RADIATION PROTECTIVE DRUG AET ON MITOTIC GROWTH IN THE BONE MARROW OF THE RAT BY THE STATHMOKINETIC METHOD (thesis). Lytle, James Bert. College Station, Tex., Agricultural and Mechanical Coll. of Texas, 1964. 75p.

The effect of varying concentrations of AET on the mitotic index in the rat was demonstrated. Twelve weanling rats of the Holtzman strain per test were injected with AET intraperitoneally and colcemid intravenously. Two animals were sacrificed at each of the time periods following the AET and colcemid injections. Concentrations of 200, 300, and 400 milligrams of AET per kilogram of body weight were employed. The six time intervals were 0, 15, 45, 75, 105, and 135 minutes. Two thousand cells were counted per slide of bone marrow cells smeared. The number of cells in mitosis per 1000 cells counted is the mitotic index. Colcemid was used in concentrations of 1.0 and 2.0 mg/kg body weight. In the statistical analysis it was demonstrated that the differences are real, all of which had a significant F value. The inhibition of mitosis was in direct proportion to the concentration of AET. As a result of the primary findings adult Holtzman rats received 400 mg/kg (35 animals), 300 mg/kg (35 animals), and 0 mg/kg (30 animals) chronically administered AET every 12 hours for 132 hours followed by 900 roentgens of gamma irradiation. No protection was demonstrated by the chronically administered AET. (Dissertation Abstr.)

Radiation Hazards and Protection

See *also* HEALTH AND SAFETY.

144 (EUR–2460.d,f,i,n) RADIOACTIVE CONTAMINATION OF FOODSTUFFS IN THE COUNTRIES OF THE COMMUNITY IN 1963. (European Atomic Energy Community). 1965. 67p. Dep. mn.

In German, French, Italian, and Dutch.

Food contamination with ^{89}Sr, ^{90}Sr, and ^{137}Cs was measured in EURATOM countries during 1963. Radiation doses to the population resulting from milk contaminated by ^{89}Sr and ^{90}Sr and dietary contamination by ^{90}Sr were estimated. The pattern of contamination is illustrated by tables and graphs. Average contamination was calculated and compared with that in the United States, Canada, and the United Kingdom and with milk data for 1962 in the EURATOM countries. (TCO)

145 (IA–989) RELATIVE TOXICITY OF RADIONUCLIDES. Feige, Y.; Gairon, P. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Aug. 1965. 24p. Dep. mn.

A method for determining the relative toxicity of radionuclides is presented, which is based on the comparison of the toxicity according to both the weight and the activity classifications. The method utilizes a color code combined with two-dimensional graphical representation of the toxicity. Toxic stable elements can also be included. (auth)

146 (NYO–3086-1) RADIOACTIVITY STUDIES. Annual Report, December 1, 1964–November 30, 1965. Eisenbud, Merril; Petrow, Henry G. (New York Univ., N. Y. Inst. of Environmental Medicine). Sept. 1, 1965.

Contract AT(30-1)-3086. 132p. Dep. mn; CFSTI $4.00 cy, $1.00 mn.

Separate abstracts were prepared for the 10 sections of the report. (H.G.D.)

For abstracts of individual sections see: 22, 23, 147–153, and 417.

147 (NYO–3086-1, Pt.I) RESIDUAL BODY BURDENS AND ELIMINATION RATES IN RADIUM DIAL PAINTERS. Berk, Harold; Laurer, Gerard; Schneider, Roger; Block, Linda; Drew, Robert; Cohen, Norman; Eisenbud, Merril (New York Univ., N. Y. Inst. of Environmental Medicine). 21p.

In collaboration with the New Jersey Department of Health, a total of 138 subjects with a history of radium exposure was counted at the whole body counter facilities of the Environmental Radiation Laboratory during the past four years. The accuracy and reproducibility of the procedures are discussed, and comparative data from other laboratories are presented. The uncertainty of the estimates is about 8%. The data obtained from serial measurements made during the past four years yields a half time of approximately 16 ± 2 years for radium retention in man 30 to 40 years after ingestion. The exponential model seems to provide more reasonable estimates of elimination rates than the power function, which does not fit these data adequately. There is evidence that in some individuals the radon offgassing factor may diminish progressively over a period of years. This increases the retention of Ra C and results in an apparent increase in ^{226}Ra body burden when the estimate is made by whole body counting techniques using a constant offgassing factor. This finding emphasizes the necessity of using both breath radon measurements and whole body counts for precise estimates of ^{226}Ra body burdens. Accordingly, this practice is now being followed in all cases. (auth)

148 (NYO-3086-1, Pt.IV) THE DIETARY INTAKE OF ^{228}Ra. Petrow, Henry G.; Schiessle, Walter; Cover, Arthur (New York Univ., N. Y. Inst. of Environmental Medicine). 10p.

The total diet samples collected by Health and Safety Laboratory for New York City, Chicago, and San Francisco were analyzed for their ^{228}Ra content. Nineteen different food categories were analyzed for each city. An average ^{228}Ra intake of about 1 pC/day was found, with New York City being somewhat higher than Chicago and San Francisco. (auth)

149 (NYO–3086-1, Pt.V) THE ^{210}Pb CONTENT OF SOME SELECTED FOODS. Petrow, Henry G.; Cover, A. (New York Univ., N. Y. Inst. of Environmental Medicine). 3p.

A preliminary survey of the ^{210}Pb content of some fresh vegetables was made. Spinach was shown to contain a greater amount than any of the other vegetables analyzed, presumably because of folial absorption of atmospheric ^{210}Pb, the naturally occurring 22-year daughter of radon. (auth)

150 (NYO-3086-1, Pt.VI) RADIOCHEMICAL ANALYSIS OF BRAZILIAN SAMPLES FROM REGIONS OF HIGH NATURAL RADIOACTIVITY. Petrow, Henry G.; Schiessle, Walter J.; Cover, Arthur; Cohen, Norman (New York Univ., N. Y. Inst. of Environmental Medicine). 6p.

Samples of water, foods and teeth were analyzed for heavy radionuclides. Analyses of mineral water samples collected from Caxambu indicated that the ^{226}Ra plus ^{228}Ra concentration of many potable springs is in excess of 100 pC/l. Food samples submitted from Araxa and Tapira were shown to contain up to 80 pC ^{228}Ra/gm ash. Citrous fruits were particularly high. The foods from this area of Brazil seem to be elevated in ^{228}Ra content by a factor of about twenty. Two samples of teeth from a tribe of indigenous Brazilian Indians known to feast frequently on Brazil Nuts were found to contain about 12 times as much ^{226}Ra as normal teeth in the United States. Radium-228 measurements were not feasible due to the small size of the samples. (TCO)

151 (NYO–3086-1, Pt.VII) THE NATURAL RADIATION DOSE TO INDIGENOUS RODENTS ON THE MORRO DO FERRO, BRAZIL. Drew, Robert T.; Eisenbud, Merril (New York Univ., N. Y. Inst. of Environmental Medicine). 27p.

The feasibility of studying the dose from natural radioactivity received by indigenous rodents in remote areas was demonstrated on the Morro do Ferro, a large hill in Minas Gerais, Brazil. Estimates were made of the dose from external gamma radiation, internally deposited ^{228}Ra, and inhalation of thoron and radon. External gamma exposure was measured by releasing trapped rodents into which fluoroglass rod dosimeters were implanted subcutaneously. The dosimeters were removed after retrapping about 5 weeks later. These measurements indicated that the average dose over a several week period was as high as 0.8 mR/hr. The bone dose from ^{228}Ra was estimated by radiochemical analysis, the preliminary results of which indicate concentrations of 0.7–2.8 pC/g bone ash leading to a dose in the order of 3 Rem/year. Estimates of the dose from inhalation of the radioactive noble gases were made using field measurements of the radon and thoron content of air aspirated from rodent burrows. It was found that the thoron concentrations vary from near normal levels to 10^{-4} μC/ml. The problems involved in calculating the dose to the lung and other organs from thoron inhalation are discussed and preliminary data are given. The dose to the basal epithelium of rats exposed to the average observed thoron concentration may be as high as 3500 Rem/year. (auth)

152 (NYO–3086-1, Pt.VIII) THE RADIOACTIVITY OF FOSSIL FUELS. Petrow, Henry G.; Cover, Arthur; Eisenbud, Merril (New York Univ., N. Y. Inst. of Environmental Medicine). 2p.

Samples of fly ash and fuel oil residues were obtained from a number of localities: Alabama, Wyoming, Utah, Japan, Eastern Europe, and North Africa. The results to date tend to support the conclusion that fossil fuel plants are a source of low-level atmospheric radioactive contamination. (auth)

153 (NYO–3086-1, Pt.X) ^{55}Fe IN HUMANS. Wrenn, McDonald E. (New York Univ., N. Y. Inst. of Environmental Medicine). 7p.

Iron-55 was detected in human blood in five New York and New Jersey residents in amounts ranging from 2.5 to 6 pC milligrams of stable iron. Doses up to 7 millirads to the erythrocytes may be expected from these body burdens during the next year. Limited data on radioiron in foods suggest that body burdens in man may still be increasing. (auth)

154 (RFP–621) PLUTONIUM HAZARDS AND ACCIDENT EXPERIENCES. Putzier, E. A. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Aug. 12, 1965. Contract AT(29-1)-1106. 41p. (CONF-650710–8). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From American Nuclear Society, Meeting on Reactor Operating Experience, Jackson Lake Lodge, Wyo.

The contamination of plant environs and personnel following accidental release of plutonium was studied by the Dow Chemical Company in Golden, Colorado. Experience with three such accidents is related. Even with fairly severe accidents, plutonium release to the plant environs was insignificant. Prophylactic measures for personnel working with plutonium are discussed, and methods for treating persons accidentally exposed are evaluated. DTPA treatment was found to be a very effective decontaminating agent in those persons exposed accidentally at the Rocky Flats Plant. (H.G.D.)

155 (JPRS–31646) STANDARDS OF RADIATION SAFETY. Kalaydzhiev, Vl.; Popov, Iv. Translated from Durzhaven Vestn., No. 59, 2-6(June 27, 1965). 22p. (TT-65-32141). CFSTI $1.00 cy, $0.50 mn.

Standards of radiation safety were developed on the basis of the standards adopted in 1964 by the member countries of the Council of Mutual Economic Cooperation. These standards include the maximum permissible doses of external and internal irradiation and maximum permissible concentrations of radioactive substances in the water and in the air. These standards are listed. (M.O.W.)

156 RADIOCHEMICAL ANALYSES FOR ^{90}Sr, ^{137}Cs, ^{226}Ra, AND ^{40}K IN NATURAL AND PROCESSED MATERIALS IN AUSTRALIA. Green, J. H.; Pallister, E. T. (Univ. of New South Wales, Sydney). Australian J. Sci., 27: 199-202(Jan. 1965).

Sr-90, ^{226}Ra, and ^{40}K were determined in some selected materials, such as tobacco, tea, and coffee. Results are given for analyses of various processed materials in Australia, as well as for rainwater in Sydney. Apart from the tea samples, the results showed levels of ^{90}Sr similar to those found in flour from Australian wheat. This was so even though the ratio of total strontium to total calcium was lower in these samples than in flour. A sample of Chinese tea had a ^{90}Sr content (2080 $\mu\mu C$/g Ca), which was about 340 times the content of Sydney milk sampled at the end of 1961. The results indicated a greater fallout in tea-growing areas and perhaps a selective uptake of ^{90}Sr by the tea plant. For tea packed in Australia the highest figure (321 $\mu\mu C$/g Ca) was 53 times the level in the milk samples. A rough estimate of the maximum amount in a pot of Australian tea gave 13 $\mu\mu C$/l of tea, or one-thirtieth of the MPL for drinking water. The ^{90}Sr and ^{137}Cs contents in monthly precipitation collections for the two years from April 1962 to April 1964 are listed and the estimated corresponding surface fallout is shown. These results showed concentration peaks for ^{90}Sr and ^{137}Cs in October to December 1962 and November to December 1963. Average ratios of ^{137}Cs to ^{90}Sr specific activities in 1962 and 1963 were 1.34 and 1.45. Results are tabulated of the comparative contents of the three nuclides, ^{90}Sr, ^{40}K, and ^{226}Ra in tea, coffee, and tobacco. (BBB)

157 LINEAR ACCELERATOR RADIOTHERAPY MACHINE. Engineer, 219: 689(Apr. 16, 1965).

A new British linear accelerator is illustrated which is being installed in the Rotterdam Radiotherapy Institute. A major innovation in this machine is that the accelerator and x-ray head extend from an annular drum and can be rotated in a complete circle about the treatment table. Earlier machines were restricted to 220° rotation. The new machine, designated type SL75, has an x-ray beam energy of 6-Mev. A super version, with an energy of 8 Mev, is also made. These energies are considerably higher than the 4.3 Mev of earlier models, and give increased percentage doses to deep-seated malignancies. Thus the entrance dose given healthy tissue is reduced while the exit dose remains sufficiently small to avoid the skin reaction induced by higher x-ray energies. Both versions are available with electron outputs to enable electron beam therapy of near surface lesions to be carried out. The maximum electron energies are 8 Mev and 10 Mev for the standard and super models, respectively. Besides being compact, the new construction allows a longer length of waveguide to be used than in earlier models. The waveguide is mounted horizontally, and the electron beam is magnetically deflected through 90° to strike a transmission-type gold target. The resulting x-ray output after collimation and flattening is 400 rad/min at one m in air. The x-ray target, collimator, and field-defining system are designed to reduce penumbra effects. A high-density optical field defining system and range-finding pointers ensure rapid and accurate setting up of the patient. (BBB)

158 IS POLONIUM (^{210}Po) THE CANCER-INDUCING FACTOR IN EXCESSIVE CIGARETTE CONSUMPTION? Lorant, Michael. Med. Klin. (Munich), 59: 1106-7(July 3, 1964). (In German).

Smokers who consume two packs of cigarettes per day accumulate enough ^{210}Po in the bronchial mucosa from the inhaled smoke to produce α irradiation that is seven times as great as the normal environmental irradiation. Polonium is absorbed into plants by way of the leaves and roots, is vaporized at the temperatures attained by burning cigarettes (1112 to 1472°F), and is inhaled in the smoke. Most of it is phagocytized and deposited in the throat mucosa. The lowest dose that a person who smokes 40 cigarettes/day for 25 yr receives is about 36 Rem. The estimated value of 36 Rem is probably rather conservative, and doses of 100 Rem might be expected. Results were obtained from four American brands of cigarettes in a smoking machine, where 60 to 70% of the cigarettes' lengths were consumed at at a rate of 8 puffs in 6 min. Most of the vaporized Po was adsorbed onto the smoke particles. The amounts of Po in the ashes and butts were higher than in those smoked by human subjects. The actual percentages of Po that are absorbed seem to be related to the method of smoking and the amount of smoke inhaled. (TCO)

159 THE PULMONARY VENTILATION AFTER INTENSE IRRADIATION OF BRONCHIAL CARCINOMAS. Altenbrunn, H.-J.; Ritzow, H.; Lessel, A.; Rotte, K. H. (Robert-Roessle-Klinik, Berlin). Radiobiol. Radiotherap. 6: 447-53(1965). (In German).

Pulmonary ventilation was observed in patients given x-ray therapy for bronchial carcinomas. The use of radioisotopes for diagnosing the progression of recovery is discussed. (H.G.D.)

160 A VARIANT FOR MOBILE TRANSFER CONTAINERS FOR SEALED GAMMA EMITTERS. Hofmann, H.; Kirsch, M.; Schumann, E. (Radiologische Klinik und Poliklinik der Medizinischen Akademie, Erfurt, Ger.). Radiobiol. Radiotherap. 6: 491-5(1965). (In German).

A transfer container for Ra and ^{60}Co-sources with a removable chassis is reported. Isodoses for radium and ^{60}Co-loadings are given. Permissible transferring times are given depending on the transferred activity. (H.G.D.)

161 RISK OF LEUKEMIA BY IRRADIATION. Brunner, H. E. (Universitaet, Zurich). Schweiz. Med. Wochschr., 95: 892(June 26, 1965). (In German).

To date an exact relation between irradiation dose and induction of leukemia has not been established. The frequency of leukemia in Hiroshima and Nagasaki is 1561/yr/million inhabitants with an irradiation exposure of 1281 rad. It decreases with the smaller irradiation doses received farther from the hypocenter. It is 60/yr/million inhabitants exposed to 80 rad, and at an exposure of from zero to 20 rad it conforms to the usual frequency of 22/yr/million inhabitants. In general, the expectation of leukemia has been calculated as 1 to 6 cases/million for each rad of exposure. In contrast, national irradiation amounts to 1 mRem/yr/person. Occupational medical exposure to x irradiation varies between 10 and 200 mRem, and is usually confined to the thoracic and lumbar vertebrae, the os ilium, sacrum, and neck and head of the femur, which comprise 65% of the blood-forming marrow. Fluoroscopy produces very high irradiation exposure. A fluoroscopic skin dose of 4.25 rad/min is more than 1000 times as great as the dose from a thoracic x-ray photograph, which amounts to 3 mrad/min. Irradiation exposure from diagnostic radioisotopes is minimal, but therapeutic doses of radioisotopes involve a definite risk of leukemia induction. As a whole, the average irradiation exposure from medical uses is about ½ of the environmental irradiation exposure, or ½ mRem/yr. However, up to now 12 cases of leukemia induced by occupational exposure to irradiation have been documented. Irradiation exposure should be kept to a minimum by strict observance of protective measures. (BBB)

Radiotherapy and Radiodiagnosis

Refer also to abstract 667.

162 (CONF-640918-2) PHOTOGRAPHIC ISODOSE MEASUREMENTS IN INHOMOGENEOUS MATTER. Netteland, Olav (Norsk Radiumhospital, Oslo). [nd]. Contract AT(30-1)-2607. 10p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Symposium of High Energy Electrons, Montreux, Switzerland.

Preliminary results from electron photographic isodose measurements in inhomogeneous media are presented. All measurements were made at three different energies, 11.0, 18.5, and 30.0 Mev. Factors considered in the results were influence of air volumes, influence of low density materials, build up effects, and influence of solid bone. (M.O.W.)

163 (STI/DOC/10/42, pp 71-91) RADIOISOTOPE APPLICATIONS IN MEDICINE. (International Atomic Energy Agency, Vienna (Austria)).

Summaries are presented of work done on three research contracts: improvement of the radiorenogram technique and comparison with other tests of renal function, hemodynamic studies on patients suffering from Chagas disease, and iron metabolism and biosynthesis of hemoprecursors in high-altitude polycythemia. (D.L.C.)

164 (TID-3077(Suppl.1)) RADIOISOTOPES IN MEDICINE. A Selected Literature Search. Ward, Helen L. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Oct. 1965. 261p. Dep. mn; CFSTI $6.00 cy, $1.25 mn.

This annotated bibliography contains 3160 selected references to publications from 1958 through 1963 on the use of radioisotopes in medical diagnosis, therapy, and research. Author and report number–availability indexes are included. (C.H.)

165 (N64-20943) STUDIES IN MEDICAL RADIOLOGY. Translated from Med. Radiol., 9: No. 2, 22-8; 64-71; 75-84; 94-103(1964). 59p. (JPRS-24452; OTS-64-31197). CFSTI $1.50 cy, $0.75 mn.

Separate abstracts were prepared on two papers. Four papers were abstracted previously and appeared in NSA Vol. 18 as nos. 17544, 17545, 17650, and 17651. (C.H.)

For abstracts of individual papers see: 166 and 167.

166 (N64-20943, pp 1-8) THE CONDITION OF CARCINOMATOUS LARYNGEAL MUCOSA AFTER X-RAY THERAPY. (CLINICAL, MORPHOLOGICAL AND HISTOCHEMICAL PARALLELS). Lapchenko, S. N. Translated from Med. Radiol., 9: No. 2, 22-8(1964).

Morphological changes are described that were observed in the laryngeal mucosa of patients given radiotherapy, at doses of 380 to 14,300 rads, for carcinoma of the larynx at time intervals varying from a few days to 7.5 yr before examination. An attempt was made to establish dose-injury relations, but this was difficult since all radioinduced changes were superimposed on a morphological background characteristic of the stage of tumor growth. Results showed that immediately after exposure to about 1800 rads x radiation a bright hyperemia of the mucosa occurred that disappeared by the end of the second week, after which the mucous membrane assumed its normal appearance. During the first few weeks after irradiation with total absorbed doses from 2500 to 5000 rads, necrotic changes and edema of the blood vessels were observed in many connective tissue cells. From 6 to 10 mo after irradiation these injuries had disappeared and the content of acid mucopolysaccharides in the cells was reduced. A total absorbed dose of 5,400 to 8,300 rads caused a pronounced membranous epithelitis and pronounced edema that persisted for over 3 mo in many cases. Examination of tissues one yr after exposure showed thickening of the epithelium, altered collagen fibers, lymphoid-plasma cell infiltrations, marked atrophy of the mucosa, loss of basic substance by collagen and elastic fibers, and pronounced vascular sclerosis. (C.H.)

167 (N64-20943, pp 35-46) THE USE OF CYBERNETICS IN THE DEVELOPMENT OF RADIATION THERAPY. Kruglyakov, I. O.; Lindenbraten, L. D.; Likhtenshteyn, E. A. Translated from Med. Radiol., 9: No. 2, 94-9(1964).

The advantages of using computers to calculate radiation doses for the treatment of cancers are discussed. (C.H.)

168 SARCOMA FOLLOWING RADIATION FOR RETINOBLASTOMA. Raivio, Ilkka; Tarkkanen, Anti (Helsinki Univ.). Acta Opthalmol., 43: 428-9(1965).

A case report is presented on a three-yr-old girl with bilateral retinoblastoma. The left eye was enucleated and the right one treated successfully with x rays. After 29 treatments, the retinal mass disappeared, and a useful vision was retained. Eight years later a fibrosarcoma was noted in the right orbit. In spite of x ray and ^{60}Co treatment of the tumor, it progressed, and the patient died one year later. Evidently, this tumor was a postradiation complication. Tumor appearance varies from 2 to 30 yr, but the most frequent period seems to be between 5 and 8 yr. In almost all cases the total dose of radiation exceeds 10,000 R. However, in some cases a considerably smaller dose has been sufficient to produce a tumor. In any method of radiotherapy, where in addition to the tumor the surrounding tissues are exposed to large doses of x rays, postradiation tumors about the eye may occur. At present the conservative treatment for retinoblastoma comprises cytostatic agents injected into the common carotid artery and the use of ^{60}Co applicators, with light coagulation. It is hoped that complications may be avoided by combining these methods. Three other reports of sarcoma development in an irradiated eye are reviewed. (TCO)

169 ^{59}Fe ABSORPTION MEASUREMENTS BY WHOLE-BODY COUNTING: STUDIES IN ALCOHOLIC CIRRHOSIS, HEMOCHROMATOSIS, AND PANCREATITIS. Deller, D. J. (Royal Adelaide Hospital). Am. J. Digest. Diseases, 10: 249-58(Mar. 1965).

A procedure is described for measuring ^{59}Fe absorption by whole-body counting which avoids the problems involved in fecal radioactivity measurements. To determine Fe absorption in alcoholic cirrhosis, hemochromatosis, and pancreatic disease radioiron was administered with carrier iron and pancreatin. Iron absorption was measured using 1 μC of ^{59}Fe with 5 mg of iron as ferrous sulfate. Whole-body activity was measured following administration of the isotope to establish the 100% point, and again 14 days later when the unabsorbed radioactivity had been excreted. Absorption was estimated as the difference between these two measurements. Ten normal subjects absorbed 4 to 20% of the oral dose of 1 μC of ^{59}Fe with a mean absorption of 9.7%. Enhanced absorption of iron was observed in each category of pancreatic disease. Absorption of ^{59}Fe was increased in patients with iron deficiency and in patients with iron overload. Absorption of ^{59}Fe was reduced in many instances by pancreatin. A positive difference between the two tests, representing diminished absorption after pancreatin, was observed in 19 of 24 patients. (TCO)

170 HIGH-PRESSURE OXYGEN AND RADIOTHERAPY. Churchill-Davidson, I. (St. Thomas Hospital, London). Anglo-German Med. Rev., 2: 519-23(Sept. 1964).

Progress in the use of hyperbaric oxygen techniques in radiotherapy to increase the radiosensitivity of cancer tissue is considered. Irradiating tumors in patients breathing high pressure oxygen involves a number of technical and physiological problems, which are discussed. Most patients are now treated in the conscious state, breathing oxygen at 3 atm absolute, and are given a maximum tissue dose of 3500 to 4000 rad in 6 treatments over 18 to 19 days. Only selected patients are anesthetized with intravenous pentobarbitone. This markedly increases the latent period before oxygen convulsions occur, so that anesthetized patients breathe oxygen at 4 atm. Results are described in the radical treatment of 172 patients. The overall response to treatment has been better than would have been expected from conventional radiotherapy and in 15 to 20% of cases it was dramatic. Moderate-sized tumors with good blood supply, which had not caused excessive damage to the normal surrounding structures, have shown the greatest oxygen effect. Especially good results have been obtained in treating tumors of the tongue, floor of mouth, tonsil, nasopharynx, and larynx. Response of secondary squamous carcinoma in lymph glands appeared to be markedly enhanced by oxygen. The one serious complication has been necrosis of the laryngeal cartilages. It usually occurs 6 to 9 months after treatment and has happened in 21% of patients in whom the larynx was irradiated. Cartilage in other sites has not been affected. It appears that laryngeal cartilages are normally partially anoxic. Serial measurements of oxygen tension in tumors showed in several instances little or no rise in oxygen tension when 100% oxygen was breathed for periods of up to ½ hour, but a rapid rise to not less than 900 mm Hg, when oxygen at 3 to 4 atm was breathed. Favorable results have been far higher than would have been expected without the use of oxygen. (BBB)

171 ADVANTAGES OF TREATING SKIN NEOPLASIA WITH SOFT X RAYS. Van Caneghem, P.; Mattelaer, G.; Van Herle, R. (Universite of Louvain, Belg.). Arch. Belg. Dermatol. Syphilig., 19: 206-12(1963). (In French).

Physical factors of 29-, 43-, and 60-kv x rays and ^{60}Co γ rays were compared prior to a description of the treatment of skin cancer by a deep-tissue, bone-sparing technique. Depth attenuation curves for the different intensity radiations are plotted in terms of skin, soft tissue, and bone. A 55-year-old woman, suffering from a basocellular epithelioma of the nose, that had not penetrated to the interior tissues or to bone, was treated with soft (43- to 50-kv) x rays. Irradiation was given in three fields over a period of three weeks (5800 R, in fractions of 350 R; 6400 R, in fractions of 400 R; and 7000 R, in fractions of 500 R). The nasal passages were protected by lead shields. The object of the treatment was to irradiate all the neoplastic tissue, sparing the neighboring tissue and bony structures. Thus, the Chaoul method was rejected; the short focal distance it requires results in an excessive number of fields and a consequent imprecision. Furthermore, with this method the coefficient of absorption in bone varies greatly with the length of exposure. Soft x rays, on the other hand, do not penetrate as deeply into bone as those emitted by the Chaoul apparatus, γ rays of Ra, ^{60}Co, or ^{198}Au. (BBB)

172 CANCER OF THE EYELID: DO'S AND DON'TS OF IRRADIATION. Schulz, Milford D. (Massachusetts General Hospital, Boston). Arch. Opthalmol., 67: 278-9 (Mar. 1962).

Some recommendations are given for preventing ocular injury during irradiation of tumors in and around the eye. (TCO)

173 TREATMENT OF HYPERTHYROIDISM. Regniers, P.; van Raepenbusch, F.; Vermeulen, A. (Rijksuniversiteit, Ghent). Belg. Tijdschr. Genessk., 20: 1012-22(Oct. 1, 1964). (In Flemish).

Hyperthyroid patients may be treated with thyroid inhibitors or radioiodine, ^{131}I; use of each of these is discussed. The inhibitors include thiocyanate, perchlorate, nitrate, and the thyrostatics thiouracil and methimazole. Practical application of the latter is described with attention to toxicity, rest, precautions, goiter, and exopthalmos, and results. The discussion of ^{131}I treatment includes diet before treatment, and calculation of the therapeutic dose; the latter should take into account ^{131}I uptake by the thyroid, rate of release of ^{131}I from the thyroid, degree of hyperthyroidism, volume of the thyroid, morphology of gland, and age of the patient. The estimate of the ^{131}I dose in mC is (g thyroid × 10)/(% absorption of test dose). Thyroid function after treatment is followed for two to three months. Other data discussed include complications after treatment. Hypothyroidism may occur relatively frequently, but in 20 yr no cases of ^{131}I-induced cancer of the thyroid or of ^{131}I-induced leukemia were substantiated in patients treated with radioiodine. Results to be expected in usual cases with such treatment are described. The method of subtotal thyroidectomy and the relation of choice of therapy to age of the patient is discussed, radioiodine treatment usually being avoided in the younger patients. (BBB)

174 RADIOISOTOPE SCANNING IN THE DIAGNOSIS OF LIVER DISEASE. Sorensen, Leif B. (Argonne Cancer Research Hospital, Ill.). Biochem. Clin., 3: 47-53 (1964).

The use of three radioisotopes for detection of liver lesions is described. Colloidal ^{198}Au is actively taken up by the cells of the reticuloendothelial system; when the particle size exceeds 3 to 4 mμ, the Kupffer's cells of the liver account for 80 to 90% of the uptake. The ^{198}Au has a 0.41-Mev γ ray and a half-life of 2.69 days. It is given intravenously in a dose of 2 to 4 μC/kg body weight; scanning is started from 30 to 60 min after injection, at which time removal of particles from plasma is complete. The material is permanently retained by the liver. This has the advantage that a scan can be repeated at any time for 48 hr. The disadvantage of colloidal ^{198}Au is the high radiation dose to the liver, which is of the order of 8 to 15 rad. Rose bengal (tetraiodotetrachlorofluorescein) is selectively taken up by the polygonal cells of the liver following its intravenous administration, and is rapidly excreted into the biliary system. This dye, tagged with ^{131}I, is given intravenously in a dose of 2.5 to 3 μC/kg body weight. Scanning is started 20 min after injection, beginning at the inferior border of the liver. With the fast excretion of ^{131}I-labeled rose bengal, a continuously decreasing counting rate is encountered as the scan progresses. The change in concentration which can amount to 30 to 50% during the scanning procedure, results in production of artificial defects toward the end of the scan. This difficulty can be partly overcome by administration of a blocking dose of 100 mg of nonradioactive rose bengal ten min prior to injection of the tracer material. Due to the short biological half-life, the radiation dose to the liver is low, about 0.5 rad. (TCO)

175 EVALUATION OF TREATMENT OF ADVANCED PRIMARY AND SECONDARY GINGIVAL CARCINOMA. Krishnamurthi, S.; Shanta, V. (Cancer Inst., Madras). Brit. Med. J., 1: 1261-3(May 11, 1963).

Effectiveness of radiotherapy in the treatment of extensive oral cancers in 188 patients was evaluated, with attention to the side-effects of radiation and their correction. The patients received initially either ^{60}Co beam therapy or high-voltage x-ray therapy, using a 250-kv unit and a beam with a half-value layer of 2 mm of copper. A tumor dose of 6500 to 7500 rad in about six weeks, using the γ beam or 5000 to 5500 rad in about five weeks, using x rays, was delivered. Irradiation was followed by composite resection eight weeks later, wherever the mandible was affected by radiation or where a residue of tumor was present. The three- and four-year survivals in the resected cases were 71.4% and 66.6% against a survival of 28.3% and 8.3% in the nonresected group. In the group where resection was thought unnecessary the corresponding survival rates were 63.6% and 57.1%. Irradiation impaired neither the operating technique nor the subsequent healing. The results suggest that in the treatment of advanced oral cancers planned irradiation with subsequent composite resection is more likely to improve the survival rate than either irradiation or surgery alone. (TCO)

176 EFFECT OF TREATMENT OF THYROTOXICOSIS ON EXOPHTHALMOS. Greig, W. R. Royal Infirmary, Glasgow); Aboul-Khair, S. A.; Mohamed, S. D.; Crooks, J. Brit. Med. J., 2: 509-10(Aug. 28, 1965).

The effectiveness of ^{131}I in hyperthyroid therapy was compared with that of methylthiouracil in 72 thyrotoxic patients. Mild-to-moderate exophthalmos was present in each case but none was malignant. Of the 30 patients treated with methylthiouracil, the degree of exophthalmos diminished in one, did not change in five, and increased in 24 when they became euthyroid. Of the 42 patients treated with ^{131}I the degree of exophthalmos diminished in five, did not change in four, and increased in 33. The rate of control of thyrotoxicosis was significantly more rapid with methylthiouracil than with radioiodine. No correlation was found between the rate of control of thyrotoxicosis and the increase in exophthalmos with either type of treatment when correlation coefficients were derived. The previous suggestion that thyrotoxicosis associated with exophthalmos should be controlled slowly to minimize the expected increase in the protrusion of the eyes was not confirmed in this study. There appears to be no therapeutic advantage from a slow rate of control. It is concluded that a rapid return to the euthyroid state in thyrotoxicosis will have no adverse effects on the degree of exophthalmos. (TCO)

177 ON THE USE OF PLASTOBALT IN DERMATOLOGICAL THERAPY. FIVE YEARS' EXPERIENCE. Midana, A.; Lovera, G. (Universita, Turin). Bull. Soc. Franc. Dermatol. Syphilig., 70: 715-17(Sept.-Oct. 1963). (In French).

Plastobalt is a commercial designation for a plastic material in which ^{60}Co is imbedded in small gold spheres. One g of plastobalt contains about 64 of these spheres uniformly distributed in the plastic mass. The activity of the prepa-

ration is initially 0.77 mC/g. Plastobalt can be adapted to the shape and dimensions of the surface to be irradiated, and thus permits the characteristics of the dose absorbed to be modified somewhat. For example, use of plastobalt permits irradiation of soft tissue without significant irradiation of adjacent bone or cartilaginous tissue. According to past experience plastobalt is specifically useful in treatment of localized epitheliomas localized in the region of the head, where there are many anatomical irregularities. (TCO)

178 POST-RADIOTHERAPY RECTITIS. Guerre, J. Concours Med., 85: 6353-8(Nov. 23, 1963). (In French).

In treatment of tumors two requirements must be met. One of these is that the irradiation must include a large volume. Also, if the tumor is not very radiosensitive, then the difference between the dose that must be used and a dangerous dose is small. As a result of these factors the rectum is frequently exposed to irradiation, and serious complications may ensue. The author reports results of irradiation of uterine cervical tumors in 400 patients who were treated with Ra and x irradiation, and 350 who received combinations of treatment with Ra and radiocobalt. In about 2% of irradiated patients symptoms of rectitis were observed. In 0.5% of the cases rectitis resulted from accidental overdosage. Scarcely ever was this due to Ra irradiation. More often with x irradiation it resulted from ignorance or lack of caution. Sometimes when radiocobalt was used, excessive irradiation was administered because this type of irradiation did not give any cutaneous indication of over-dosage. The author describes the clinical symptoms of rectitis, its diagnosis, pathological anatomy, and treatment. (BBB)

179 EXPERIENCE WITH THE CHLORMERODRIN-Hg BRAIN SCAN: A PRELIMINARY REPORT OF 163 CASES. Turner, Oscar A.; Laird, A. Thomas; Weiss, Sanford R. (Youngstown Hospital Association, Ohio). Conn. Med., 29: 254-6(Apr. 1965).

A report is given on 163 consecutive cases in which radiomercury was used for diagnosis of brain tumor. Chlormerodrin-^{203}Hg was used except in a few cases where ^{197}Hg was substituted, the latter having a half life of 65 hr compared to 28 days for the former. With a Magnascanner, scanning was done 4 hr after the intravenous administration of about 800 μC of Chlormerodrin, the patient having received 1 to 1.5 ml of mercuhydrin the day previous as a blocking agent to reduce or minimize the renal uptake. A 19-hole, focused collimator was used. Of the 163 scans, 50 were positive, showing a localized increase of radiomercury uptake recognizable in both the lateral and anteroposterior or posteroanterior view. Of the 50 positive scans, 42 represented lesions, with 8 cases in which no tumor or similar type lesion was found. There were six instances in which the scan failed to identify the tumor. Of these, three were cerebellar lesions, two being metastatic tumors and one being an astrocytic cyst removed surgically. Tumors of the sella are often missed due to uptake by the facial and temporal musculature while those in the posterior fossa, such as cerebellar and cerebellopontine angle tumors, are frequently obscured due to uptake by the heavy suboccipital muscles. It is concluded that this diagnostic procedure offers no significant hazards, is readily acceptable to the patient, and does not upset the circulatory or intracranial pressure balance as might occur in other diagnostic means. The method is of great value not only in identifying primary tumors of the brain, but in recognizing single and multiple metastases. No correlation was found between the type of activity of the tumor and the density of the isotope uptake. (BBB)

180 THE EVALUATION OF MARROW CELL DISTRIBUTION FOR THE REDUCTION OF BONE MARROW DOSE IN X-RAY STUDY SERIES. Franzen, J. (Universitaet, Mainz). Deut. Med. Wochschr., 90: 171-7(Jan. 22, 1965). (In German).

It is shown that for the posterior-anterior orientation increasing the focus-to-film distance at 120 kv reduces the dose, but it has no effect on the marrow dose in the anterior-posterior orientation at this voltage. Reversing the orientation, together with increasing the distance, reduces the dose more than if either one is done alone. Reversing the orientation and increasing the voltage from 80 to 120 kv, with an 80-cm distance reduces the marrow integral dose by a factor of 7.1 gR. Correspondingly, values of the marrow dose in mR are reduced from 47.99 to 6.72. These changes in orientation have no significant effect on the gonadal dose. For a posterior-anterior photograph the gonadal dose is between 0.033 and 0.054 mR, and for a photograph directed anterior-posteriorly the gonadal dose is between 0.030 and 0.045 mR. (TCO)

181 THE TREATMENT OF HYPERTHYROIDISM. Klein, Erich (Medizinische Klinik und Poliklinik der Medizinischen Akademie, Duesseldorf). Deut. Med. Wochschr., 90: 924-7(May 14, 1965). (In German).

General treatment of hyperthyroidism is symptomatic and depends on how the heart, circulation, and nervous systems are affected. Reserpine is useful for sedation and reduction of stroke volume and pressure, but it does not restore the circulatory system to normal. More specialized treatment measures include surgery, irradiation with ^{131}I, and medication with antithyroidal substances. Often only one of these measures is suitable, because the patient's age, size, ocular symptoms, and thyroid status must be taken into account. An abrupt decrease in excess thyroid hormone production may cause exacerbation of thyroid growth and ocular symptoms due to increased activity of the hypophysis. Each of the three methods of treatment have their advantages and disadvantages. Surgery is the preferred method of treatment for large or entirely substernal goiters and for small toxic adenomas. Surgery is very advantageous for patients under 40 yr old, but above 40 yr ^{131}I treatment is best, particularly in inoperable patients. Preparation for surgery includes administration of antithyroidal drugs and large doses of I for 8 to 20 days. If the thyroid is very large or for toxic adenomas the I treatment alone should be given. The effects of oral ^{131}I can be observed 3 to 4 weeks after administration. This treatment is contraindicated during pregnancy or before the age of 25 yr. After 40 yr this treatment is preferred for almost all cases of hyperthyroidism. The gradual effects of ^{131}I therapy are enhanced by fractionation of the dose over several weeks. Thyroid hormone should be administered along with antithyroidal substances to maintain its blood level and prevent reactive increase in thyroid size and eye symptoms. Antithyroidal drugs are suitable for use in pregnancy or in cases where ^{131}I or surgery is inadvisable. In 30% of hyperthyroid patients antithyroid drugs are indicated, while ^{131}I and surgery are preferred in 60 and 10% of these cases. (BBB)

182 ON THE PROBLEM OF THE DOSE BURDEN IN X-RAY DIAGNOSIS. Keller, M.; Rohloff, F.; Krause, W.; Eck, G. (Kernforschungsanlage, Juelich, Ger.). Elektromed. Ihre Grenzg., 10: 10-11(Mar. 1965). (In German).

The amount of information that can be obtained from an x-ray image is related to the energy of the quanta available. The optimal energy for visualization seems to be in the range from 50 to 80 kev. Below 50 kev the information obtainable decreases rapidly because of the very abrupt increase in dose burden. Above 80 kev the decrease is very slight. The optimal working voltage for the x-ray tube probably is from 100 to 160 kv or above. Working voltages between 50 and 80 should not be used because with the contrast obtained, a very high dose burden is imposed on the patient. The contrast in detail resolution of the single picture elements is a good measure of the information content of the image. Too much detail resolution reduces the contrast necessary, and the ability to vary the detail resolution is very important. Optimal information content is reached if the detail resolution corresponds to the detail necessary for diagnosis. The use of image systems with variable detail resolution is very important for transfer of pictures of weak intensity. The number of contrast steps statistically obtainable is proportional to the intensity of the radiation. The perceptions of contrast in looking at a light image changes logarithmically in the eye. In order to ensure that

statistically resolvable contrast steps in an x-ray photo will be perceptible as brightness steps, the picture transfer system must be provided with a gradation resolver that has a defined contrast transfer function. A television monitor viewing system is probably the best. A combination of a tube with a semiconductor photocathode and indirect signal transfer known as the "super vidicon" has some advantages. (BBB)

183 COSMETIC IRRADIATION TREATMENT OF THE FACE AND ITS DANGERS. Rosenthal, Wolfgang. Fortschr. Kiefer- Gesichtschr., 8: 71-5(1962). (In German).

Irradiation damage in the region of the face and jaw may result from intentional or accidental irradiation treatment. Intentional irradiation injuries include the destruction of malignant tumors, where the net effect of irradiation may be beneficial and prolong survival considerably. Often plastic surgical procedures, if properly used, can be used to repair the irradiated area, giving an improved functional and cosmetic effect. Accidental irradiation injuries may arise from bad technique or improper use of irradiation treatment where it is not required. Many harmless skin conditions, such as acne vulgaris, hirsutism, microsporosis, warts, cavernous hemangiomas, or keloids, do not need be treated by irradiation. Sometimes dermatoses or systemic diseases, such as diabetes, thyrotoxicosis, nephritis, etc., may reduce skin resistance to irradiation so that it becomes very susceptible to radiation damage. The development of basiliomas or skin carcinomas may take as long as 10 or 20 yr after exposure to the irradiation. (BBB)

184 EVALUATING THE RADIATION THERAPY PATIENT. Turner, James E. (Community Hospital, Geneva, Ill.). GP, J. Amer. Acad. Gen. Pract., 32: 101-5 (Aug. 1965).

Medical care of patients undergoing radiation treatment is discussed, especially from the points of view of preventing injury to normal tissue and treating radiation injuries when they occur. Irradiation of an internal tumor requires delivery of the dose to the correct volume of tissue. Meticulous localization of the volume requiring treatment is essential. This is accomplished by careful x-ray examination, with administration of a contrast medium if necessary. The ease of local eradication of tumors by radiation is roughly correlated with their histology (although overlap of radioresponse between very sensitive and poorly sensitive cell types occasionally occurs). Within each cell type, tumor response varies with size, location and irradiation technique. Radioresponses are classified for various types of tumors. A tumor can seldom be successfully irradiated beyond the radiation tolerance of its local bed. Preservation of unusually radiosensitive organs in or near the tumor-bearing volume creates difficult problems in shielding and in radiation field shaping. Medical measures for increasing the patient's general tolerance become important. Normal organ and tissue tolerances to radiation are outlined. Preoperative radiotherapy is valuable in the treatment of endometrial adenocarcinoma but its value elsewhere remains to be proved. High-dose preoperative irradiation increases the risk of wound and tissue necrosis after surgery. Prophylactic irradiation of an uninvolved area adjacent to known irradiated or surgically removed disease is justified for certain sensitive tumors but not for resistant ones. The most helpful measure for increasing the success of radiation treatment consists of continuous medical support of the patient. Extraction of teeth or correction of anemia, malnutrition, infection, or coexisting disease may be required as a preliminary measure. Radiation therapy is then planned so as to tax the patient's local and systemic tolerance as little as possible. During treatment, the efficacy of irradiation can be improved by the use of proper diets, dressings, blood, antibiotics, analgesics, sex hormones, adrenal steroids, antitumor drugs, or antiemetic tranquilizers whenever indicated. Treatment plans or goals may be changed by frequent assessment of tumor size and response and patient reaction. (BBB)

185 GOITERS DURING THE YEARS OF GROWTH. Klein, Erich (Medizinische Klinik und Poliklinik der Medizinischen Akademie, Duesseldorf). Internist, 6: 30-40(Jan. 1965). (In German).

Simple juvenile goiter is characterized by a normal PB^{131}I value of about 0.2% of the dose/l serum, and a normal PBI value of 4 to 8 μg. Uptake of ^{131}I is uniform through the entire thyroid. However, the uptake of ^{131}I is high. Even though the goiter can be removed surgically, in about 50% of the cases there may be recurrence unless the patient is maintained with 100 to 200 μg of I daily. Thyroid hormone may be administered, but the dosage must be carefully controlled to avoid development of factitious hyperthyroidism or hyperactivation of the thyroid parenchyma. Simple juvenile solitary goitrous nodes may sometimes indicate a neoplastic area. In more than half of the cases the child is known to have been irradiated previously for hyperplasia of the thymus or tonsils, swelling of the lymph nodes, etc. Limited studies indicate that from 10 to 30% of solitary nodes are papillary adenocarcinomas, and the remainder are adenomas or cysts. These nodes do not take up ^{131}I well and should be removed or treated. The prognosis for differentiated adenocarcinoma is favorable if it is intensively treated. Hyperthyroidism without goiter and toxic adenomas occur much less frequently in children than in adults. Ocular symptoms are infrequent and rarely progressive. Hyperthyroidism in children is not typified by a large gland. Increased blood pressure with a wide amplitude is more indicative than finger tremor and a warm skin. Serum cholesterol is somewhat decreased, osteoporosis of the spine and premature closure of the epiphyseal grooves with stoppage of growth are other symptoms. Values of butanol-extractable iodine greater than 7 μg % are indicative. Treatment consists of antithyroid drugs and small doses of reserpine. (BBB)

186 FACTORS INFLUENCING THE INCIDENCE OF RADIATION INJURY IN CANCER OF THE CERVIX. Powell-Smith, C. (Montreal General Hospital). J. Assoc. Can. Radiologists, 16: 132-7(June 1965).

A survey was made of 318 cases of cervical carcinoma treated with intracavitary Ra and external ^{60}Co γ radiation to establish factors affecting occurrence of radioinduced gastrointestinal injury. Comparison was made between 36 cases suffering complications and 282 cases which did not. The usual course of treatment consisted of two applications of intracavitary Ra one week apart, amounting to 3200 to 4000 mg-hr in the uterus and 4000 mg-hr in the vagina. This was followed immediately by irradiation to the parametria using ^{60}Co teletherapy, with central shielding or split fields, giving a midpoint dose of 3500 to 4000 rad in three to four weeks. Anterior and posterior opposing fields were used. The 36 cases with Grades II and III injuries comprise the following: rectum, 21 cases; sigmoid colon, 7 cases; small bowel, 5 cases; and extrinsic reaction, 3 cases (diffuse pelvic fibrosis). These 36 are referred to as the G. I. injury group, and are compared with the uncomplicated group. No difference between the two groups was found regarding the following parameters: age, histologic grade of tumor, ^{60}Co unit used (either long or short treatment distance), anterioposterior diameter of the lower trunk (pelvis), order of administering the treatment (i.e., radium before or after external radiation, or in the middle). When the incidence of complications examined by stage of disease, a slightly higher proportion of early cases was seen in the G. I. injury group. There was a significant relation between the incidence of G. I. injury and previous abdominal surgery; 18.2% of those with previous abdominal surgery developed G. I. complications, compared with 7.1% of those with no previous surgery or disease. The transverse dimension of the pelvic fields influenced the incidence of bowel complication, but longitudinal field size did not. Among the G. I. injury group, 86% had been treated through fields more than 20 cm across, but only 40% of the uncomplicated group had these large portals. This was significant. No correlation between dose and bowel injury could be found. With regard to survival, the group sustaining G. I. injury fared slightly better, stage for stage,

than the uncomplicated group. Survival rate was better in the group with complications, especially in advanced cases. Retroverted position of the uterus was associated with an increased incidence of this complication by a factor of nearly 2. (BBB)

187 RADIOPELVIMETRY BY THE SWEDISH METHOD. **Lesperance, Jacques; Sansregret, Andre; Bernier, Gilles (Hopital Maisonneuve, Montreal). J. Can. Assoc. Radiologists, 16: 35-9(Mar. 1965). (In French).**

An evaluation was made of the method of Borell and Fernstrom (Acta Radiol., Suppl. 191, 3-97(1960)), which has been alleged to improve diagnostic reliability as well as reduce the radiation exposure of the fetus. In this method, the patient sits on the x-ray table, leaning forward, as the x-ray beam is directed downward toward the sacrum. In this position, most of the body of the fetus is outside of the x-ray beam. The fetal gonads, in particular, may be spared irradiation. Results of the method in 100 cases are described. According to the original authors, if the two diameters of the pelvic outlet (tip of sacrum to symphysis and posterior intertuberous) add up to more than 25 cm, the delivery should be normal. If less than 25 cm, the interspinous is measured and if the three diameters add up to more than 34 cm, the delivery should also be normal. Between 32 and 34 cm, it is impossible to foresee and below 32 cm a cesarian section is to be expected. In the present series of 100 cases, 32 were dystosic. It is concluded from this study that if the sum of the posterior intertuberous and the sacropubic measurement is above 26 cm, the delivery is always normal and that if between 25 and 26 cm, the delivery is nearly always normal except if the fetal skull is larger than normal or the fetus postmature; if less than 25 cm, the interspinous measurement is added. If the total dia of outlet (posterior intertuberous, tip of sacrum to symphysis, interspinous) add to less than 34, the delivery has been nearly always abnormal with mid-pelvis forceps. If between 34 and 35, the delivery is impossible to foresee but is frequently abnormal. If above 35, the delivery is normal. (BBB)

188 THE INFLOXRAY MANSCREEN. **Mansker, Joseph S. (Queens Hospital Medical Center, Jamaica, N. Y.). J. Urol., 93: 504-7(Apr. 1964).**

Daily exposure to scattered radiation can result in a much higher dose to the radiologist and technician than what the patient receives from the primary x-ray beam at intervals separated by months or years. The principal causes of overexposure to x radiation in diagnostic radiology are: exposure to primary x-ray beam, exposure to scattered radiation from the patient, unfiltered primary x-ray beam, unlimited primary x-ray beam, failure to use radiation shields, defective tube head protection, high ma-sec low kvp techniques, and failure to measure actual radiation received. If the radiologist stays in the room with the patient, he should use a protective screen. Persons within their reproductive years exposed to x rays should have maximal shielding. In diagnostic radiography, radiation measurements at the position of the cystoscopist's body trunk indicate an exposure of 20 mR/100 ma-sec due to scattered radiation; the dose to his hands may be many times greater. Most of the scattered rays emerge at an angle of 90° from the incident x-ray beam and have the same average energy as the useful beam. This Compton scattering does not greatly degrade the photon of ionizing radiation. The intensity of scattering varies inversely as the square of the distance from the source. The closer one works to the source of the broad x-ray beam, the greater will be the intensity of the rays upon a smaller area, for example, the urologist's hands. Furthermore, the ratio of scattering at the cystoscopy position is 80 times greater than at the center of the beam. When horizontal cineradiographic units are used for cystoscopic procedures, the multiple brief exposures are cumulative and, in effect, may be larger than for single radiographs. Radiation is projected from the tube head when located on the underside of the table. Scattered radiation from the patient is considerable. Scattering from the undersurface of the table is of much greater intensity than the scattering by the patient. A new method for x-ray shielding is presented. Wearing a lead apron does not protect the urologist who elects to perform tests while he remains in the x-ray zone. His head, neck, eyes, arms, hands, feet, and large parts of his body remain exposed to primary, stray, and scattered radiations. The infloxray manscreen which is described is specially designed to overcome the hazards involved when the urologist injects contrast medium into the distensible channels of the urinary tract and uses x rays to produce a radiograph. The screen is illustrated and its use explained in various urologic procedures. The urologist remains at examining position when contrast medium is injected and while the x-ray tube is concurrently energized for finely timed radiographs. The screen is adaptable for use in other branches of radiography: pediatrics, gynecology, obstetrics, neurology, proctology, and individual viscera examinations where contract media are used for diagnosis. Operators using manual injection techniques are fully protected from radiation hazards. (BBB)

189 MANAGEMENT OF POLYCYTHAEMIA VERA. **Easson, E. C.; Halnan, K. E.; Russell, M. H. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Lancet, 2: 390(Aug. 21, 1965).**

Comments are made on an earlier study of the use of ^{32}P in treatment of polycythemia vera, and a preliminary report is presented here of another series of patients with this disease treated with radiation. In an earlier survey reviewing 127 patients with polycythemia vera managed without radiation therapy, it was concluded that the risk of leukemogenesis is such that it is better to avoid the use of radiophosphorus for patients under 55 to 60 yr of age. This view ignores the main object of any treatment, prolongation of useful life, and emphasizes only one cause of death, whether or not it is related to treatment. In the present survey of a similar series of 107 patients treated primarily by radiotherapy, there were no deaths from leukemia, and, of more importance, there was no significant difference between the survival rate of these patients and that of the patients of the earlier series. For these reasons, and also because management with radiophorphorus is simpler than chemotherapy for both patient and physician, the continued use of ^{32}P seems justified for the time being. (BBB)

190 ACUTE RADIATION NEPHRITIS. **Mostofi, F. K. (Armed Forces Inst. of Pathology, Washington, D. C.). Med. Ann. District Columbia, 34: 64-7(Feb. 1965).**

Clinical and pathologic findings in three cases diagnosed as acute radiation nephritis are described. Two of the patients died with evidence of renal failure eight months after radiation therapy to the renal area; the third died from other causes, but at autopsy a similar renal lesion was found. Histologically these three kidneys presented an identical picture. The architecture of the kidney was markedly altered in the irradiated areas, showing atrophy of tubules, hyalinization of the glomeruli, and fibrosis of the parenchyma; more severe changes involved the glomeruli and arterioles and, to a lesser extent, tubules and parenchyma. The glomeruli were large and somewhat hypocellular. The capillary loops were fused; the capillary walls appeared thickened by an eosinophilic fibrillary material, which was PAS-positive. The glomerular cells displayed pyknosis. The capillaries of some glomeruli showed fibrinoid necrosis, and some contained fibrin thrombi, while others were completely engorged. The glomerular capsule was essentially normal, and no glomerular adhesions or crescents were seen. There was no periglomerular infiltration. The tubular epithelium showed extensive damage. Many of the epithelial cells of the convoluted tubules showed thickening and vacuolation of the cytoplasm in which rare hyaline droplets were found. Intimal fibrous thickening and medial fibrosis were seen in the larger arteries. Endothelium of the smaller vessels was swollen. The literature dealing with the effects of radiation on the kidney is briefly reviewed. It is suggested that the term chronic radiation nephritis is a misnomer. There is no evidence of nephritis either in human patients or in experimental animals. The

renal changes are more severe than those encountered in nephrosclerosis. Nephrosclerosis is present, but it is superimposed on a kidney in which there has occurred extensive damage to the tubular epithelium. (BBB)

191 EFFECTS PRODUCED BY SODIUM NICOTINATE, RIBOFLAVIN, AND FOLIC ACID ON PHAGOCYTOSIS DURING X-RAY TREATMENT OF PATIENTS WITH NEW MALIGNANT GROWTHS. Chukichev, E. M.; Yuditskii, B. Ya. Med. Radiol., 10: No. 7, 61-5(July 1965). (In Russian).

Observations are reported for 98 women with uterine cervix cancer of the II and III degree, subjected to local x ray therapy in a total dose of 10,000 to 12,000 roentgen over a period of 20 days. The control group comprised 20 patients, 29 others received sodium nicotinate daily in a dose of 50 mg, three times a day; 17 were given riboflavin in a dose of 10 mg per day; 14 were given folic acid in a dose of 2 mg per day; and 18 were given a mixture of sodium nicotinate and riboflavin in amounts of 50 and 10 mg a day respectively. The vitamins were found to weaken the general reaction of the patients to local irradiation, to prevent or attenuate the leukopenic reaction, and inhibit the phagocyte activity. The best results were achieved by using sodium nicotinate and the mixture of vitamins PP + B_2. (tr-auth)

192 PROCTO-SIGMOIDITIS FROM IRRADIATION. Peracchia, G.; Gagnoni Schippisi, G. Minerva Radiol., Fisioterap. Radiobiol., 10: 299-300(July-Aug. 1965). (In Italian).

The occurrences of 5 cases of radio-induced proctosigmoiditis in 59 cases of vesicular neoplasia treated with radiotherapy are reported. The radiolesions are discussed with respect to the anatomy, radiography, and clinical progress of the neoplasia. (J.S.R.)

193 COMPARISON BETWEEN RADIOLOGICAL AND RECTOSIGMOIDOSCOPIC PICTURES AFTER RADIOTHERAPY OF CERVIX CARCINOMA. Savignoni, R.; Jenkner, F. (Universita, Rome). Minerva Radiol., Fisioterap. Radiobiol., 10: 306-8(July-Aug. 1965). (In Italian).

The results of the radiological examination of the rectal sigmoid region after radiotherapy of cervix carcinoma is compared with the results of the rectosigmoidoscopic examination. The differences found in the two types of examination are discussed. (J.S.R.)

194 THE INTERPRETATION OF THE BIOLOGICAL EFFECT OF THE RADIO-CHEMO-THERAPEUTIC ASSOCIATION IN THE TREATMENT OF MALIGNANT TUMORS. Stoppa, I. M.; Agati, G. (Universita, Turin). Minerva Radiol., Fisioterap. Radiobiol., 10: 335-7(July-Aug. 1965). (In Italian).

The results of an experimental study in rats on the leukocyte variation as a result of combined radio-chemotherapy and the administration of drugs with a stimulating effect on leukopoiesis are reported. The rats were exposed to 250 R in conjunction with endoxan. The leukopoiesis-stimulating drugs administered were DPN, cysteamine, ascorbic acid, albema, and steranabol. The results are shown graphically and show that the combination of radio- and chemotherapy causes an increase of the leukopenia in comparison with the phenomona caused by either of the two treatments alone. This effect is at a maximum when the chemotherapy is administered 72 hrs after the whole-body irradiation. It is possible to obtain a more rapid recovery of the leukocytes with the administration of the leukopoiesis-stimulating drug. The mechanism of the association is discussed. Some clinical results obtained in the combined therapy on patients suffering from malignant neoplasia are tabulated. (J.S.R.)

195 RADIATION IN PREGNANCY. Latteier, Karl K.; Garber, Lawrence O. (Crittenton Hospital Detroit). Minnesota Med., 38: 153-7(Feb. 1965).

Attempts are made to assess the safety of various radiologic and radioisotope tests conducted during pregnancy, and some recommendations are made for reducing the possible hazards. (TCO)

196 TREATMENT OF MALIGNANT DISEASE OF THE THYROID. Haynie, Thomas P.; Beierwaltes, William H.; Nofal, Mohamed M. (Univ. of Michigan, Ann Arbor). Mod. Treat., 1: 208-22(Jan. 1964).

Experience in treating thyroid cancer with ^{131}I in 250 patients is recounted, with extensive data on doses used, tissue uptake of ^{131}I, early and late complications, and clinical results. This experience shows that all patients showing evidence of ^{131}I concentration by the tissues after attempted surgical removal should have ^{131}I therapy. Forty % of the patients had uptake in the thyroid bed after total surgical thyroidectomy without evidence of metastases elsewhere. Success was obtained in freeing 91% of these cases of evidence of ^{131}I uptake with a mean dose of 136 mC (range, 80 to 505 mC). In order to assure an adequate first dose of ^{131}I, 150 to 175 mC is now routinely given. Second doses are in the range of 175 to 200 mC. Following operation, 52 patients showed concentration of ^{131}I demonstrable in regional lymph node metastases. Following ^{131}I therapy, 35 (67%) of these patients were free of evidence of carcinoma for a mean interval of 5.1 yr after therapy. The mean dose of ^{131}I necessary to free a patient of uptake in this category was 148 mC (range, 80 to 370 mC). The first side-effects noted after a large dose of ^{131}I, part of the acute radiation syndrome, consist of anorexia, nausea, and vomiting, beginning 6-8 hours after administration of the dose and lasting for a variable period, but rarely longer than 3 days. Other complications are described. (TCO)

197 USE OF ^{99m}Tc IN HEPATIC SCINTILLOGRAPHY. Degrossi, O.; Seeber, J. Martinez; Gotta, H.; Olivari, A.; Chwojnik, A. (Hospital-Escuela Jose de San Martin, Buenos Aires). Nature, 208: 86-7(Oct. 2, 1965).

Hepatic pictures of excellent resolution were obtained by intravenous injection of colloidal antimonium sulfide which takes up ^{99m}Tc. Concentration of this substance in the liver allows tracing to be performed only 10 min after injection and its activity is still at adequate levels after 180 min. After 24 hr the activity eliminated by urine was 10 to 15%. Activities of 0.4 to 1.0 mC were used. (P.C.H.)

198 APPRAISAL OF THE HAZARDS OF DENTAL RADIATION. Sloane, Robert B. N. Y. State Dental J., 30: 117-18(Mar. 1964).

It is suggested that the excessive concern for the protection of the patient from radiation has resulted in the too general acceptance of techniques that produce dental radiographs of poor diagnostic quality. If the radiograph is not of diagnostic value, the patient has been subjected to radiation unnecessarily. For a dental radiographic to be of value as a diagnostic aid, it should have the following minimum qualities: (1) A discernible difference between the teeth and their supporting structures. (2) A discernible difference between the enamel, dentin, and carious lesions. (3) A discernible difference between the enamel, dentin, and carious lesions. (4) A discernible periodontal membrane, if it is not pathologically absent. The three areas that may be affected by exposure to dental radiation that are considered are the tissue directly exposed to the primary beam, the gonads, and the entire body. The local effect on tissue exposed to a properly coned and filtered beam is so minimal that for all practical purposes it can be disregarded. The general body effects of dental radiation are evaluated basically in their effect on the hemopoietic and endocrine systems, and dental patient can be appropriately shielded from the insignificant accumulative effects of small, infrequent, and controlled exposures. As for the gonadal effect, in dental x-ray per exposure, gonadal structures in the male receive about 0.34 mR and in the female 0.06 mR. Even this minimal genetic hazard can be eliminated by covering the patient from shoulder to knee with a lead rubber apron having a 0.5-mm lead equivalent. It appears that the much feared gonadal effect of dental x ray has been overstated. Therefore, reducing the exposure time by increasing the kilovoltage and milliamperage, and accepting films of poor diagnostic value, seems to be protection of questionable value. It is concluded that dentists have unwittingly adopted techniques that mirror

the general concern about x-ray exposure and have accepted radiographs of less than diagnostic value. Dentists have been so concerned with sparing patients unnecessary x-ray exposure that they have accepted standards for diagnostic films that do not meet the basic requirements outlined above. (BBB)

199 CAN AND TO WHAT EXTENT MAY RADIOTHERAPY BE USED WITH A PREGNANT WOMAN WITH HEMOPATHY? Pierquin, B.; Tubiana, M. (Institut Gustave-Roussy, Villejuif, France). Nouvelle Rev. Franc. Hematol., 2: 259-64(Mar.-Apr. 1962). (In French).

A decision as to whether to employ radiotherapy for treatment of a pregnant woman with a hemopathy should be the result of consultation between the physician, hematologist, and radiologist. The decision is limited by a rigorous need to remain within the limits of radiation tolerance. In effect, these limits are determined by three specific needs. The first of these is the risk of irradiation of the fetus. During early periods of pregnancy, irradiation may cause death of the fetus. Maldevelopment of the fetus may result from exposure to less than 50 R of irradiation from the second to the seventh week of pregnancy, when the central nervous system or optical may be damaged the most. Less obvious than these somatic injuries are genetic changes which may be induced by irradiation. Considering three types of irradiation, such as 250-kv x irradiation, telecobalt irradiation, and 22-Mev betatron irradiation, there are differences in the fraction of the dose that is scattered to adjacent tissues. In each case the scattered irradiation decreases with the lateral distance from the beam. For 250-kv x irradiation at distances of 2, 4, 10, and 30 mm from a beam that is 10 × 10 cm at the skin surface, measured in a plane located 10 cm below the skin, the fractions of the dose scattered are 20, 10, 1, and 0.1%. For telecobalt irradiation these values are 10, 5, 1, and ≤1%, respectively, and for betatron irradiation the corresponding values are 5, 2, <1%. These values may differ somewhat, depending on the instrumentation and measurement techniques used, but they give some indication of the irradiation that an embryo might be exposed to in the event that irradiation treatment is administered to a pregnant woman. (BBB)

200 RADIOACTIVE PHARMACEUTICALS. Seidenglanz, G.; Kny, L. (Deutsches Institut fuer Arzneimittelwesen, Berlin). Pharm. Praxis, Beilage Pharmazie, 5: 109-11(1965). (In German).

A list of the radioactive preparations found in the seventh edition of the Deutsches Arzneibuch (DAB) is given. After a short history of radioactivity studies, the preparation of several isotopes, for example ^{32}P, and the development of neutron sources is described. The use of radioactive preparations in medicine is then described: in circulatory diagnosis ^{22}Na, ^{24}Na, ^{32}P, ^{36}Cl, ^{42}K, ^{51}Cr, ^{59}Fe, and ^{131}I may be used. In tumor diagnosis ^{32}P as phosphate and ^{131}I as iodide are chiefly used, together with labeled organic compounds. In thyroid diagnosis, ^{131}I is used; for the liver, ^{131}I-bengal rose; and for the kidneys, Na_2-^{131}I-iodohippurate. Diuretics labeled with ^{203}Hg have been used in recent years. Radiation therapy is also discussed: specific indicators and treatment with colloids (chromium ^{32}P-phosphate, $^{52}MnO_2$, ^{65}ZnS, and ^{198}Au) are discussed. The German Democratic Republic has facilities for production of many isotopes; it imports $Na^{131}I$ solution and $Na_2{}^{52}CrO_4$ injection solution from Hungary and ^{198}Au colloid injection solution from Bulgaria, and exports all the other preparations in the DAB. Mersalyl-^{203}Hg now appears in the DAB. Use of radioactive pharmaceuticals is described in the Charité and Robert Roessle Klinik in Berlin, the Medizinische Akademie in Dresden, and the university clinics of Jena and Rostock. (BBB)

201 PREGNANCY COMPLICATING CARCINOMA OF THE CERVIX: REVIEW OF 33 CASES. Jacobs, James P. (State Univ. of Iowa Coll. of Medicine, Iowa City). Postgrad. Med., 38: 177-82(Aug. 1965).

Problems encountered in using radiotherapy in treating cervical carcinoma in pregnant women are considered with reference to 33 cases diagnosed and treated during various stages of gestation. A combination of external irradiation and radium application is the recommended treatment for invasive carcinoma of the cervix. Results of treatment, from records providing follow-up information covering five or more years in 28 of the 33 cases, show 66% survival in 1st and 2nd trimester cases, and 18% in 3rd trimester cases. Thus, prognosis of cervical carcinoma is as good in the pregnant patient as it is in the nonpregnant patient, provided prompt and thorough treatment is given. (BBB)

202 PRIORITIES IN MEDICAL RESPONSIBILITIES. Adrian, Lord (Trinity Coll., Cambridge, Eng.). Proc. Roy. Soc. Med., 56: 523-8(July 1963).

Responsibilities of the medical profession in assessing the hazards of radiation to man, and of keeping his exposure in medical diagnosis to acceptable limits, are discussed. Health hazards other than those due to radiation are considered. (TCO)

203 CARCINOMA OF THE THYROID. Till, A. S. (Radcliffe Infirmary, Oxford). Proc. Roy. Soc. Med., 58: 309-18(May 1965).

The geographic incidence, etiology, histopathology, and treatment of 205 cases of thyroid cancer were investigated. The possible etiologic influence of ionizing radiation and therapeutic use of ^{131}I were examined the course of this survey. Use of external x-ray therapy and radioiodine to treat various types and stages of thyroid carcinoma is considered. When the lymph glands in the neck are inoperable or when distant metastases have spread by the bloodstream from a follicular type of carcinoma, it is usual to attempt treatment by radioiodine. The object of this is to induce the uptake of a therapeutic dose of radioiodine in metastases by removal of all normal thyroid tissue, which would normally compete for the iodine, by radical excision which is the quickest and best method of achieving this. If this is impossible on account of local spread or general unfitness for operation, an ablation dose of radioiodine is used: full myxedema should develop in two to three months and the secondary deposits may then show a max uptake of radioiodine; when this occurs dramatic improvement may result and pulmonary and other metastases disappear. However, this desirable result rarely occurs; and only two cases in this series where such an improvement was achieved were seen. Radioiodine therapy is likely to give results only with differentiated cancer and is generally ineffective with anaplastic growths. On the other hand, failure of a tumor to take up radioiodine does not necessarily mean that the method is inapplicable unless all normal thyroid gland has previously been removed. This treatment is too complicated to entrust to departments which are not used to dealing with large amounts of radioactive material and taking care of the after-effects on bone marrow and lung. It is important, even if treatment with radioiodine is not successful, local radiotherapy with the administration of thyroxine often effectively prolongs life and controls pain. It is suggested that therapeutic use of ^{131}I has not altered the prognosis much for most patients suffering from carcinoma of the thyroid. (BBB)

204 EARLY AND LATE EFFECTS IN CLINICAL RADIOTHERAPY: MODERN ASPECTS OF AN ANCIENT PROBLEM. Bistolfi, F. (Univ., Genoa). Progr. Biochem. Pharmacol., 1: 663-73(1965).

Various factors which influence the injury of normal tissues during tumor radiotherapy are considered, such as absorbed dose, irradiated volume, time factors, fractionation, and LET. An improved dose calculation system is explained. This simplified system permits simultaneous and correlated evaluation of the space and time factors in treatment planning. (TCO)

205 OUR EXPERIENCES WITH HIGH-ENERGY RADIATION AT THE CANCER CLINIC OF CHARITE. Gietzelt, F.; Degner, W.; Doerffel, F. W.; Banaschak, A.; zur Horst-Meyer, H.; Riessbeck, H. H. (Humboldt-Universitaet, Berlin). Radiobiol. Radiotherap. 6: 429-38 (1965). (In German).

The possibility of clinical work with supervolt therapy is reported. The chances of recovery of carcinomas of the single organs are discussed. Metastases of the lymph nodes were found to be curable by electron therapy. Carcinoma of the larynx in stage I and II is especially suitable to electron irradiation as well as carcinoma of the vulva. Carcinomas of the breast and of the esophagus are well suitable to high-energy quantum radiation. Supervolt therapy of the bronchial carcinoma was not feasible. In radiation therapy of carcinoma of the bladder prognosis depends on the fact if there are already complications on the part of ureters or the renal pelvis or not. Pre-irradiation surgery inhibited recovery of bladder carcinoma. High-energy quantum radiation of the betatron has proved more tolerable in this case as well as in carcinomas of other organs. In collum carcinoma biaxial pendulum irradiation is recommended. (TCO)

206 THE GONAD DOSE IN RADIATION THERAPY OF NON-TUMOROUS DISEASES. Schumann, E.; Lademann, W. (Radiologische Klinik und Poliklinik der Medizinischen Akademie, Erfurt, Ger.). Radiobiol. Radiotherap. 6: 455-7(1965). (In German).

Gonadal doses from radiotherapy of non-tumorous diseases is of the magnitude that prophylactic measures during irradiation are preferable. Methods for decreasing gonadal doses without interfering with therapeutic effectiveness are discussed. (H.G.D.)

207 RADIOISOTOPES TODAY. McCartney, R. N. (Cancer Inst., Melbourne). Radiographer, 11: 6-11(Dec. 1964).

Clinical applications of radioisotopes are reviewed with emphasis on instrumentation used to detect them. The extensive diagnostic use of ^{131}I is outlined. A new thyroid function test uses ^{131}I-labeled triiodothyronine (T_3). T_3, a thyroid hormone carried in the blood serum, is an indication of the thyroid function of the patient. By adding ^{131}I-labeled T_3 to a sample of serum and determining the amount absorbed by the serum, the level of the patient's T_3 can be assessed. The test has the advantage that no radiation needs to be given to the patient which makes it particularly good for children. In some ^{131}I tracer studies it is often required to know the excretion rate in urine after a dose. To facilitate the counting of bulk urine a shielded ring of six G-M counters was built. Two other radioisotopes are discussed that are used mainly for hematological tests. Radiochromium (^{51}Cr) is a γ emitter having a half life of 28 days. A sample of the patient's red blood cells is labeled by incubating with about 100 μC ^{51}Cr and this sample is then reinjected into the patient. The red blood cell volume is determined using a dilution technique, and the life of the red blood cells may be assessed by taking serial blood samples. If there is destruction of the red blood cells by either the liver or spleen, this can be ascertained by taking daily counts over the heart, liver, and spleen for about ten days after the injection. The scintillation counter used is described. The second isotope, useful in hematology, radioiron (^{59}Fe), is a β-γ emitter with a 45-day half life. When a tracer dose of about 10 μC of ^{59}Fe is bound to a sample of plasma and injected into the blood stream, it is cleared into these body stores and bone marrow. The 50% clearance time of the ^{59}Fe from the plasma, normally about 70 min, is determined by taking five blood samples over a period of about 75 min. Instrumentation has enabled these last two tests to be combined. The response curves of a scintillation counter to the two isotopes are shown, ^{51}Cr has a single low-energy γ ray whereas ^{59}Fe has two high-energy γ rays which, due to being very close together, may show as a single peak. Diagnostic uses of ^{32}P and ^{60}Co are also mentioned. A special miniature counter is described which was developed to assist in the uptake studies of ^{32}P in skin and the eyes. A half-inch photomultiplier is mounted behind a very small CsI crystal. Over the crystal is a very thin sheet of aluminum that only absorbs ~10% of ^{32}P emission. This counter is more sensitive and easier to use than G-M counters. (BBB)

208 A NEW METHOD FOR OBTAINING MULTI-FIELD AND ROTATIONAL DOSE DISTRIBUTIONS IN ^{60}Co TELETHERAPY. MacDonald, J. C. F. (Univ. of Western Ontario, London). Radiology, 85: 716-24(Oct. 1965).

A method is described by which libraries of precalculated isodose distributions of general usefulness in isocentric cobalt-60 therapy can be produced. Single-field isodose patterns are digitized as polar matrices, which form the input data for an IBM-7040 computer program. The center-normalized multi-field or rotational distributions are produced by the computer in the form of digital matrices. A semi-automatic polar isodose plotter for producing the initial isodose patterns and an automatic punch-card reader and point plotter for the production of the resulting distributions in graphic form are described. (auth)

209 MANAGEMENT OF HODGKIN'S DISEASE CO-EXISTENT WITH PREGNANCY. Becker, Melvin H.; Hyman, George A. (Columbia-Presbyterian Medical Center, New York). Radiology, 85: 725-8(Oct. 1965).

A review indicated that Hodgkin's disease per se does not influence either the course of pregnancy or the condition of the fetus; nor is the course of Hodgkin's disease influenced by pregnancy. When active Hodgkin's disease develops in a pregnant patient, any treatment should be delayed as long as possible to avoid harming the fetus. Certainly, if at all feasible, no treatment should be administered in the first trimester (the period of major organogenesis). If therapy becomes necessary, local disease should be given the most penetrating radiation possible, to keep the fetal dose to a minimum. Measurements to compare the various radiation therapy units indicated that the internally scattered radiation was the least from the 22.5 Mev betatron, more from the cobalt unit, and most from the 250 kv unit. (P.C.H.)

210 DAMAGE TO THE SMALL INTESTINE BY RADIOTHERAPY. Graham, John B.; Villalba, Rafael J. (Roswell Park Memorial Inst., Buffalo). Surg. Gynecol. Obstet., 116: 665-8(June 1963).

Six cases of severe damage to the small intestine from radiation were seen among about 450 patients with primary cancer of the cervix, 200 with previously treated cervical cancer, and 350 patients with other types of gynecologic cancer treated with radiation. These cases are summarized along with those of three other patients. All but one of the patients in the present series was thin, and all patients had undergone a laparotomy previously and/or had sepsis in the pelvic area. The fixation of the intestine in the cul-de-sac or in the right side of the pelvis apparently resulted in a higher than usual dose to the fixed segment. The normal mobility of intestine keeps the exposure to any one area low. Thus, thin patients or those who have had previous surgical intervention or sepsis should have a lower dose of external radiation and a higher dose of intracavitary radium to reduce the risk of damage. Complications and other damaging effects are reported. (TCO)

211 TRANSFORMATION OF CARCINOMA TO CARCINOSARCOMA AFTER RADIUM THERAPY. Sirtori, Carlo; Pizzetti, Federico (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 51: 89-95(Mar.-Apr. 1965). (In Italian).

Histologic and clinical data are given on seven patients in whom sarcomas developed after irradiation of carcinomas. Five were cases of conversion of carcinomas into carcinosarcomas, one of conversion of carcinoma into carcinosarcoma and then into fibrosarcoma, and one of conversion of carcinoma into spindle cell sarcoma. The lesions were localized in two cases in the uterine cervix, in one case in the cheek mucosa, and in four cases in the tongue. In all patients a change in the histological pattern of the tumor occurred after local radium treatment. The appearance of the carcinosarcoma occurred in four cases 16, 23, 25, and 30 years after a single radium treatment. In two patients submitted to repeated radium therapy the latent period of the conversion to sarcoma was three and four yr and the conversion of the carcinoma into spindle cell sarcoma required 15 yr. Histological and cytological

evaluation excluded the possibility of a pseudosarcomatous aspect of epithelial nests accounting for the diagnosis, and demonstrated the malignant nature of the tumors. (BBB)

212 THE STATUS OF THE PELVIC LYMPH NODES IN CARCINOMA OF THE UTERINE CERVIX BEFORE AND AFTER DEEP X IRRADIATION. Botella-Llusia, Jose (II Univ. Women's Clinic, Madrid). Z. Geburtshilfe Gynaekol., 162: 45-55(Apr. 1964). (In German).

One question that has been discussed for several yr is whether surgical operations or irradiation therapy is most effective for removal of pelvic lymph nodes infiltrated by uterine carcinoma. The frequency of metastases to the lymph nodes largely depends on the histological type of the primary tumor. Results observed in 119 extraperitoneal lymphadenectomies performed on patients with group 3 carcinoma are reported. Of these, 44 received no irradiation prior to lymphadenectomy, and 15 in each of four other groups received: 10000 to 11000 mg-hr of Ra in three sessions, Ra plus 3000 to 4000 R of conventional x irradiation, Ra plus 4000 to 6000 R by pendulum x irradiation, and Ra plus 6000 to 7000 R of deep ^{60}Co irradiation. Out of the 44 unirradiated patients, metastases were found in 14 (31.8%). In the other four groups the incidence of lymph node metastases was 33.3, 20.0, 13.3, and 6.7%, respectively. These results suggested that while the irradiation treatments had great effects on the tumor metastases it did not completely destroy them, even when the ^{60}Co irradiation was used. However, until it is established that 100% of the carcinoma infiltrated lymphatic tissue is destroyed, it cannot be said for certain that depth therapy with irradiation will protect the lymph nodes against carcinoma metastases. For this reason surgery is necessary. The degree of invasion of the lymph nodes is least with the Mullerian type of carcinoma, is more with the Malphigian type, and is greatest with adenocarcinoma. Mullerian carcinoma occurs the most frequently. (BBB)

213 ELECTRO- AND CARDIOGRAPHIC STUDIES OF RADIATION-TREATED PATIENTS WITH MAMMARY GLAND CANCER. Pawlow, Z.; Zotschew, Z.; Harbov, I. (Third Municipal Hospital, Sofia). Z. Kreislaufforsch., 54: 425-34(May 1965). (In German).

Cardiac changes were studied in 26 women. Before operation for breast cancer, they had received 1250 to 2000 R doses of x rays (250-R single doses) and postoperatively 3000 to 4000 R (in doses of 200 R). The heart had been within the radiation field in each case. Six patients had also received local injections of 80 to 170 mC of ^{198}Au. Fourteen of the x-irradiated patients had experienced symptoms of radiation sickness: anorexia, hypotension, and leuko- and lymphopenia. In all 26 patients analyses were made of the electrocardiographic (ECG) changes and in 17 also ballistocardiographic (BCG) changes. ECG changes proved to be minor and insignificant, mostly a slight lowering of the ST interval and flattening of the T wave. In the BCG, changes indicative of obvious myocardial injury were seen. Most of the BCG tracings shifted to a more advanced stage of alteration; the appearance of the single waves was retarded with respect to the Q wave of the ECG; the K and L waves became accentuated on account of a relative reduction of the J wave which became indented and broadened. One patient, 90 years of age, with marked atherosclerosis, showed an improved BCG subsequent to irradiation (3000 R of x rays and 135 mC ^{198}Au). (BBB)

214 RADIOLOGIC STUDIES OF THE GRAVID UTERUS. Bishop, Paul A. New York, Hoeber Medical Div., 1965. 279p. $14.50.

An evaluation is made of the possible hazards to the developing fetuse and maternal ovaries from irradiation, and of means to eliminate or minimize these hazards. (TCO)

CHEMISTRY

General

Refer also to abstracts 922 and 1277.

215 (CONF-650407, pp 142-77) THE DEPOSITION OF IODINE VAPOUR ON SURFACES. Morris, J. B.; Nicholls, B. (Atomic Energy Research Establishment, Harwell (England)).

The deposition of iodine vapor on various metals, glasses, concrete, and painted surfaces was studied using radioactive tracer techniques. Most of the experiments were carried out in the temperature range of ambient to 150°C, using iodine vapor concentrations in the range 10^{-2} to 10^{2} mg/m^3 in runs lasting about 2 to 4 hr. The effect of high concentrations of water vapor (40% by volume) was examined in experiments at 150°C. The results were assessed in terms of an effective deposition velocity. Other experiments performed included desorption tests, and measurements of deposition on mild steel at room temperature from air saturated with iodine vapor under static conditions. Silver and copper surfaces exhibited the highest deposition velocities (0.1 to 1 cm/sec), and it is likely that in their case gas-phase mass transfer was controlling for the particular conditions used. For these two materials, the deposition velocity showed comparatively little dependence on temperature, iodine concentration, and humidity. The behavior of the other surfaces was more complex in that large variations of deposition velocity with temperature, iodine concentration, and humidity were sometimes manifest. The results for mild steel were exceptional; it was found that the presence of water vapor considerably enhanced the deposition rate of iodine, and, conversely, the presence of high iodine vapor concentrations led to abnormally rapid oxide rusting or corrosion. Painted surfaces generally took up iodine more slowly than metals, and the deposition velocity to glass was even lower. However, concrete absorbed iodine almost as rapidly as silver and copper. (auth)

216 (CONF-650407, pp 242-75) RADIOIODINE ADSORPTION ON PARTICULATE MATTER. Clough, W. S.; Cousins, L. B.; Eggleton, A. E. J. (Atomic Energy Research Establishment, Harwell (England)).

A study was made of iodine adsorption both on particulate matter likely to be produced in the accident itself, for example, magnesium oxide and uranium oxide, and on a variety of aerosols likely to be encountered by the iodine after release to the atmosphere. Aerosols Chamber Experiments. Labeled iodine at various concentrations was released into a 6-m^3 box previously flushed with clean filtered air. Air was withdrawn at intervals through a composite sampler capable of distinguishing iodine vapor, particulate iodine, and iodine compounds. In later experiments a more elaborate sampler was used, also capable of distinguishing reversible and irreversible iodine adsorption on particles. Aitken nuclei (0.005 to 0.1 μ in diameter) produced by heating wires of nichrome, iron, uranium, or adventitious laboratory nuclei showed little adsorption over the range of iodine concentrations studied (0.001 to 0.1 μg/m^3). On the other hand, nuclei from a heated silver wire and oil fume from a vacuum pump both showed substantial but erratic adsorption. Larger particles produced by burning toluene or the fume from burning coal adsorbed 50% or more of the available iodine, and particles from burning "Magnox" (99% Mg, 1% Al) at a mass concentration of 10 mg/m^3 adsorbed 100% of the iodine up to a saturation limit of about 10 μg of iodine per cubic meter. This corresponds with approximately 4% of a monolayer. Much of this iodine was only reversibly adsorbed according to the sampler results, a somewhat surprising conclusion in view of the low equilibrium pressure of iodine in the box. Experiments with Deposited Particles. Labeled iodine in a clean dry airstream was passed over specimens of magnesium or uranium oxide deposited on a glass slide from the burning metal, and the uptake was studied as a function of iodine pressure. At coverages below 1% of a monolayer, only irreversible adsorption was observed, in contrast to the results in the aerosol chamber. Above 15% of a monolayer, both irreversible and reversible adsorption was found, but the amount of adsorption was very variable from sample to sample. Attempts were made to remove the irreversibly adsorbed iodine by treatment with various reagents. Of these, only unlabeled iodine and methyl iodide proved effective, presumably by exchange. For a given iodine pressure and particulate surface area, the adsorption on uranium oxide was less than that on magnesium oxide. Similar measurements were made with outgassed oxide in a vacuum system in conjunction with surface area determinations using ^{85}Kr and the B.E.T. method. Some differences in behavior were observed and, again, considerable variation from sample to sample, but these were not related to surface area changes. It is possible that the oxide surface is markedly affected by traces of water vapor. The following conclusions were made: (1) The adsorption of iodine on particulate matter is highly variable, depending not only on the nature of the adsorbent but also on the history of the aerosol and the presence of competing adsorbates. (2) In all systems studied, the adsorption was less than and is, under normal atmospheric conditions, very much less than a monolayer. (3) With a few exceptions, particles in the size range 0.005 to 0.1 μ appear less important for iodine adsorption than larger particles. (4) Some of the adsorbed iodine may be readily desorbed or exchanged, necessitating careful design of sampling techniques and the placing of particulate collectors upstream of the iodine vapor adsorbents in a gas cleanup plant. (auth)

217 (NIJS-R-446) UEBER DAS REINIGEN DES ELEMENTAREN FLUORS UND DESSEN EINFUELLEN IN STAHLFLASCHEN. (On the Purification of Elementary Fluorine and its Filling in Steel Cylinders). Slivnik, J.; Smalc, A.; Zemljic, A. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jan. 1965. 8p. Dep. mn.

An apparatus for the purification and the introduction of elementary fluorine into steel cylinders using the liquefaction method is described. The inflow of the fluorine into the liquid holder was regulated by a magnetic valve that is controlled by a specially constructed contact manometer. (tr-auth)

218 (STI/DOC/10/42, pp 1-22) RADIOACTIVE WASTE MANAGEMENT AND ENVIRONMENTAL RESEARCH. (International Atomic Energy Agency, Vienna (Austria)).

Summaries are presented of work done under five research contracts: ^{90}Sr in marine animals following possible release of radioactive waste in sea water, radiochemical analysis of Sr, Cs, and Pu in biological materials, studies of ion exchange in soils using radioisotopes, sorption on peat of heavy radioactive elements from liquid wastes, and effects of accidental discharge of waste solutions on purification capacity of activated sludge plant. (D.L.C.)

219 THE CHEMISTRY OF THE RARE-EARTH ELEMENTS. Topp, N. E. Topics in Inorganic and General Chemistry. Monograph 4. New York, Elsevier Publishing Company, 1965. 175p. $10.00.

After an introduction on the discovery, structure, abundance, and properties of rare earth elements, information is included on: extraction of the rare earth elements from minerals; modern separation techniques; salts of the rare earth elements; solution chemistry of the rare earth elements; unusual valency states of the lanthanide elements; compounds with elements from groups I, III, IV, and V; rare earth oxides; sulfides, selenides, and tellurides; analytical methods; rare earth metals; and applications of the rare earth metals. Isotopes of rare earth elements produced by pile radiation are appended. (P.C.H.)

220 DRUM FILTER (Engineering Materials). (Rocky Flats Plant, Dow Chemical Co., Denver, Colo.). (CAPE–1206).

5 drawings.

The rotating device described is used to separate solids from liquids in a continuous manner. The device consists of a high-density polyethylene drum filter and a 304-L stainless steel filter tub. An air sparger is included. It is constructed of 304-L stainless steel tubing. Seventeen tubes, 0.25-in. OD and 3-in. long, are used to fabricate the sparger. The tubes, which contain 60–$\frac{1}{4}$X holes, are staggered and spaced at 1-in. intervals. A stainless steel grease gun is included. (For details, see TID-4100). (M.C.G.)

221 MAGNETIC STIRRER (Engineering Materials). (du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). (CAPE–1267).

5 drawings.

The device described is used to stir solutions in a closed diffusion cell. Permanent magnets are rotated inside the cell by an external rotating magnetic field. The external magnetic field is supplied by eight electromagnets, which are constructed with elongated pole pieces to increase the field strength near the stirring magnets in both the upper and lower cell compartments. The eight electromagnets are mounted symmetrically around the outside of the diffusion cell. An iron ring mounts the magnets and completes the circuit. The stirring magnets are attached to the electromagnets as their coils are energized. Because permanent magnet stirring bars are used inside the cell, direct current in the coils surrounding the cell must be reversed every 180°. This is accomplished by rotating brushes passing over a stationary commutator. (For details, see TID-4100) (M.C.G.)

Analytical Procedures

See also Separation Processes and Procedures

Refer also to abstracts 872 and 1541.

222 (AERE-R–4975) THE DETERMINATION OF PLUTONIUM BY POTENTIOMETRIC TITRATION. Milner, G. W. C.; Wood, A. J.; Cassie, G. E. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 27p. Dep.; BIS $1.00; HMSO 5s. 0d.

An improved method for the determination of plutonium by potentiometric titration was developed. It is based on the oxidation of plutonium to the hexavalent state with argentic oxide, followed by reduction to the tetravalent state with ferrous ions added so as to give a small amount in excess. The excess ferrous is titrated with ceric sulfate added from an Agla microburette, and the end point is determined potentiometrically. A titrator was developed to automate the addition of titrant and full details of the design are given. The burette and its motor drive were designed so that they can be operated in a shielded facility. A precise method for the accurate determination of milligram amounts (1–10 mg) of plutonium has resulted, the precision being ~0.1% (1 σ) at this level. This method was used for the determination of the plutonium content of cermet samples, including PuC–Cr and PuO_2, UO_2–stainless steel. (auth)

223 (CEA-R–2760) EXTRACTION DE QUELQUES ACIDES PAR DES AMINES ALIPHATIQUES [Theses]. (Extraction of Some Acids Using Aliphatic Amines [Thesis]). Matutano, Luis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1965. 55p. Dep. mn.

Submitted to Paris Univ. (France).

Hydrochloric, nitric, sulfuric, perchloric, phosphoric, acetic, and formic acids in aqueous solution (0.05 to 10M) were extracted by amberlite LA2 and trilaurylamine in solution, 5% by volume, in kerosene and xylene, respectively. The extraction process consists of: neutralization of the amine salt; a molecular extraction, i.e., an extraction using an excess of acid with respect to the stoichiometry of the amine salt. According to the behavior of the acid during extraction, three groups may be distinguished: completely dissociated acids, carboxylic acids. phosphoric acid. This classification is also valid for the extraction of water which occurs simultaneously with that of the acid. An extraction mechanism is put forward for formic acid and the formation constant of its amine salt was calculated. (auth)

224 (CNLM–6352) ELECTRON MICROPROBE ANALYSIS OF HIGHLY RADIOACTIVE SAMPLES. Scotti, V. G.; Johnson, J. M.; Cunningham, R. T. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). Sept. 20, 1965. Contract AT (30-1)-2789. 20p. (CONF-650810–4). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Annual Conference on Applications of X-Ray Analysis, Denver.

An electron beam microprobe analyzer shielded and modified for the analysis of highly radioactive materials is described. This work discusses the instrument selection requirements, shielding, and remote sample loading and focusing concepts. Experimental results are presented demonstrating the instrument's capability. (auth)

225 (CONF-650810–2) A METHOD FOR TRACE ANALYSIS WITH AN ELECTRON MICROPROBE. Fergason, L. A. (Mallinckrodt Chemical Works, St. Charles, Mo. Uranium Div.). July 9, 1964. Contract W-14-108-eng-8. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Annual Conference on Applications of X-Ray Analysis, Denver.

A "chopped beam" system of analysis was devised for a scanning electron microprobe equipped with a 400-channel analyzer. The system was programed with circuitry which places a signal onto the X and/or Y scanning coils of the probe so that the beam jumps back and forth between two analytical areas. The same signal is used to activate alternate halves or quadrants on the 400-channel analyzer in a synchronous manner. The analyzer accumulates x-ray intensity data in the appropriate halves and quadrants as the electron beam oscillates between sample and standard or, in the case of trace analysis, between the unknown and the pure major constituent(s) for background correction. The probe may be left unattended while it is gathering information in this manner. The dwell time of the probe on a given analytical area is 6 seconds "live" time. Errors due to instrumental drift and sample contamination are nullified or minimized by this technique. Consequently, theoretical precision is closely approached for extended counting times. One hundred ppm levels of Al, Si, Ni, and Fe in uranium determined to precisions as good as ±10 ppm at the 95% confidence level. (auth)

226 (IS-T–39) NEUTRON ACTIVATION ANALYSIS OF RHENIUM IN ROCKS [Thesis]. Palino, Gerard Francis (Ames Lab., Iowa State Univ. of Science and Tech.). July 1965. Contract W-7405-eng-82. 56p. Dep. mn; CFSTI $3.00 cy, $0.50 mn.

Submitted to Iowa State Univ. of Science and Tech., Ames.

An accurate, sensitive, and relatively rapid method for the activation analysis for rhenium in complex rock matrixes was developed. This procedure involves the anion exchange separation of the activated rhenium from all other interfering radionuclides. A spectrophotometric measurement of the colored rhenium thiocyanate complex is used in the carrier yield determination. The self absorption of neutrons in the standards and samples was corrected by employing the technique of internal standards. All counting was performed on liquid samples using a gamma ray scintillation spectrometer. The procedure was found to be very well adapted to the activation analysis of molybdenum-containing ore samples and was shown to be accurate to ±5 percent or less at concentrations of 10 ppb in other ore samples. The practical limit of sensitivity in the copper ore samples analyzed appears to be about 1 ppb but with longer irradiations, larger samples, and adequate biological shielding this limit could be extended to 5×10^{-2} ppb. This procedure was shown to be as accurate and sensitive as those previously reported while of-

fering the distinct advantages of being less detailed and time consuming. (auth)

227 (KAPL-M-6448) MEASUREMENT OF URANIA DISTRIBUTION IN SOLID HOMOGENEOUS CRITICAL ASSEMBLY FUEL. Schultz, W. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). July 30, 1965. Contract W-31-109-eng-52. 26p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

A method was developed for estimating the size, number density, and urania density distribution of agglomerates in nuclear fuel consisting of a mixture of urania particles, zirconia particles, and paraffin. Fission track counting in glass plates was used as the basis for making the estimates. (auth)

228 (LA-DC-7439) PRECISION ASSAY BY FISSION COUNTING. Knobeloch, G. W. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [n.d.]. Contract W-7405-eng-36. 18p. (CONF-651112-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

For Presentation at Meeting of Central Bureau of Nuclear Measurements, Brussels.

Analyses were performed for ^{235}U, ^{239}Pu, and ^{233}U in many samples containing fission products. The analyses used comparisons of the fission-counting rate of the sample foil with that of a standard foil exposed simultaneously in the same neutron flux. The double ion chamber used in the counting, and the neutron source and exposure are discussed. The preparation of standard foils for ^{239}Pu, ^{233}U, and ^{235}U is described. Results are given of precision checks which were conducted on the fission counting techniques. Finally, conservation of standard foils and solutions is considered. (D.L.C.)

229 (MLM-1289J) RATIO DETERMINATION OF ANTIMONY TRISULFIDE AND POTASSIUM CHLORATE BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Roth, D. J. (Mound Lab., Miamisburg, Ohio). June 1965. Contract AT-33-1-GEN-53. 30p. (CONF-650634-2). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From 16th Annual Mid-American Symposium on Spectroscopy, Chicago.

An atomic absorption spectrophotometric method for the ratio determination of antimony trisulfide–potassium chlorate in 0.2–0.4 milligram ignitor beads was developed. The sample is dissolved in acids, diluted with distilled water, and aspirated directly into the acetylene–air flame of the atomic absorption spectrophotometer. Measurements of antimony and potassium concentrations are made from the same solution. The results agree with those obtained by the colorimetric iodoantimonous acid method. The analysis requires one-third the time of the conventional colorimetric method. (auth)

230 (NLCO-965, pp 4.1-5) THE EFFECT OF NITRIC ACID ETCHING ON THE NITROGEN AND CARBON ANALYSIS OF URANIUM METAL. Ellis, W. G.; Brown, E. A. (National Lead Co. of Ohio, Cincinnati).

Nitric acid etching of uranium was found to remove nitrides and carbides from the metal. This etching technique, when performed prior to quantitative analysis, consistently yields analytical results that are abnormally low for nitrogen and carbon. This bias becomes more pronounced as the surface-to-mass ratio of the sample particles increases and is proportional to the amount of uranium removed in the nitric acid etch treatment. Solvent cleaning rather than acid etching is recommended as the preliminary step in the preparation of samples for analysis. (auth)

231 (NP-15344) THE NON-DESTRUCTIVE ANALYSIS OF IRRADIATED FUEL ELEMENTS. Final Report, April 1965. Ryde, Nils (Chalmers Tekniska Hogskola, Goteborg (Sweden)). May 10, 1965. Contracts 163/RB; 163/R1/RB. Dep. mn.

Methods used for the nondestructive burnup analysis of irradiated reactor fuel elements are reviewed. A procedure that uses a bent crystal spectrometer to measure the gamma lines from fission products and relate the intensity to the amount of burnup is described. The design of the spectrometer is given. (W.L.G.)

232 (NYO-901-37, pp 80-4) X-RAY DIFFRACTION. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.).

Methods were developed for precise x-ray diffraction measurements of the effects on bone of small amounts of Sr incorporation in the mineral phase and for the determination of Sr in the presence of large amounts of Ca using x-ray fluorescence techniques. The substitution of Sr for Ca in synthetic hydroxyapatite was established and the strong discrimination against Sr during the precipitation process was studied. A theoretical study of the electronic structure of phosphates, the crystal structure of magnesium diethyl phosphate, the structure of powdered proteins, and the effects of radiation on crystalline choline chloride were studied using x-ray diffraction techniques. (C.H.)

233 (SGAE-PH-28/1965) DETERMINATION OF ^{239}Pu CONTENT IN NUCLEAR FUEL BY NEUTRON TRANSMISSION TECHNIQUE. Putz, F.; Al-Khafaji, T.; Weinzierl, P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). 1965. 10p. (SGAE-RE-3/1965; CONF-650803-9). Dep. mn.

From IAEA Symposium on Nuclear Materials Management, Vienna.

The use of neutron transmission measurements as a nondestructive method for the determination of the ^{239}Pu content in irradiated fuels is suggested. Preliminary considerations to be taken in using the resonance absorption of epithermal neutrons at 0.296 ev by ^{239}Pu in such determinations are discussed. The problem of the fission products is solved by assuming them to be a simple $1/\nu$ absorber and carrying out two transmission measurements using thermal and epithermal neutrons. Transmission vs concentration graphs are included. Recommendations are given for further work. (D.L.C.)

234 (STI/DOC/10/42, pp 57-8) SAFEGUARDS METHODS. (International Atomic Energy Agency, Vienna (Austria)).

Work was done on the destructive analysis of unirradiated and irradiated fuels. For the determination of U, the Jones reductor with ceric sulfate or chromous chloride was used successfully with a precision of ±0.3%. Solvent extraction with TTA followed by alpha and mass spectrometry was used for Pu with a precision of ±3%. (D.L.C.)

235 (Y-KG-28) SOME APPLICATIONS OF SPARK SOURCE MASS SPECTROGRAPHY TO THE ANALYSIS OF ALLOYS AND PURE ELEMENTS. Franklin, J. C.; Griffin, E. B. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 10, 1965. Contract W-7405-eng-26. 12p. (CONF-651004-2). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 9th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A spark-source mass spectrograph was used to measure impurities in elements, compounds, and alloys. A discussion is given of a few of the problems encountered and of the results obtained by this method. Emphasis is placed on two applications: determination of boron in reactor structural materials and of impurities in zone-refined Zr. (D.L.C.)

236 (AEC-tr-6621) POSSIBILITIES OFFERED BY GAMMA SPECTROMETRY IN THE FIELD OF NON-DESTRUCTIVE MEASUREMENTS ON FUEL ELEMENTS. Engelmann, C.; Brebant, C.; Gosset, J.; Roussel, E. Translated from IAEA Preprint SM-63/9b, a Paper Presented at the Colloquium on Non-Destructive Tests in Nuclear Engineering, Bucharest, May 17–21, 1965. 11p. Dep. mn; JCL $1.60 fs, $0.80 mf.

Gamma spectrometry of fission products such as ^{144}Pr and ^{106}Rh is capable of providing very useful data regarding the irradiation of fuel elements. Complementary studies will show under what conditions may simultaneous measurements of the peaks of ^{144}Pr and ^{106}Rh serve for the calculation of the depletion in uranium-235 and the enrichment in plutonium-239. The employment of anticoincidence devices applied exclusively to the problem of measurements carried out on fuel elements will permit the simultaneous

determination of several fission products. These new techniques of measurement are foreseen for the exploitation of cells whose principle was outlined; they will be used jointly with the automatic treatment of the results of measurement by means of electronic computers. (D.L.C.)

237 (NP-tr-1266) ESTIMATION OF THE HYDROGEN ISOTOPES AND OF THEIR ALLOTROPIC FORMS IN THE GASEOUS STATE. Viallard, R. Translated by W. Bleyberg (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Eng.) from Compt. Rend., 217: 349-51(1943). 6p. Dep. mn; JCL $1.10 fs, $0.80 mf.

An apparatus using a bridge assembly of two identical filaments and two resistances (one fixed, other variable) allows analysis of mixtures of H_2, D_2, and their ortho- and para-forms, by means of the ratio of the resistances of the two filaments. The factors affecting this ratio are discussed. (D.L.C.)

238 (NP-tr-1293) ACTIVATION ANALYSIS AND TEXTILE RESEARCH. Glubrecht, H. Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.), from Paper T.10 presented at the Symposium on the Use of Radioactive Isotopes in Textile Research and Industry, Lindau/Bodensee, 8–10 July 1964. Original text published in Anwendung Radioaktiver Isotope in der Textilforschung und -Technik, Thiemig-Taschenbuch No. 9, by Karl Thiemig KG, Munich 9, Germany. 15p. Dep. mn; JCL $1.60 fs, $0.80 mf.

The recent development of activation analysis, the advantages and limitations of which are discussed, has been principally directed towards increasing the number of elements detectable with good sensitivity. Apart from the use of a higher neutron flux, this aim is achieved mainly by the introduction of rapid processes, in which measurement follows immediately after a pulsed activation. The use of activation analysis for the identification of trace elements is the most important application in the textile industry. Instantaneous reactions initiated by irradiation with thermal neutrons and activation processes using other types of incident radiation, are also introducing new possibilities. Finally, activation analysis can be used where tracing procedures are to be accomplished without radioactive tracers; the tracers employed are elements which are determined by subsequent activation. (auth)

239 ANALYSIS OF DEUTERIUM OXIDE–WATER MIXTURES AND MEASUREMENT OF THE DEUTERIUM ISOTOPE EFFECT ON THE ACID–BASE EQUILIBRIUM OF N,N-DIMETHYLBENZYLAMINE USING NUCLEAR MAGNETIC RESONANCE. Leyden, Donald E.; Reilley, Charles N. (Univ. of North Calolina, Chapel Hill). Anal. Chem., 37: 1333-8(Oct. 1965).

Advantage was taken of the difference in the NMR spectrum of H^+A and of D^+A in which A is an amine to determine the D_2O content in D_2O-H_2O mixtures. The ratio of the area of the spectrum of D^+A to that of H^+A is a quantitative measure of the D_2O. Samples ranging from 2 to 80% D_2O were analyzed using a calibration curve, and relative errors of 1 to 2% were obtained. The extension of the technique to the investigation of the isotope effect on the acid–base equilibria of amines and related compounds is also discussed, and the isotope effect on the dissociation of H^+A and D^+A in H_2O and D_2O, respectively, was determined for N,N-dimethylbenzylamine. (auth)

240 REVERSED-PHASE CHROMATOGRAPHIC SEPARATION OF ZIRCONIUM AND HAFNIUM. Fritz, James S.; Frazee, Russell T. (Iowa State Univ., Ames). Anal. Chem., 37: 1358-61(Oct. 1965). (IS-1130).

A quantitative separation of zirconium(IV) and hafnium (IV) was obtained by reversed-phase chromatography using Teflon-6 as the solid support. The stationary phase was methyl isobutyl ketone equilibrated with aqueous 3M thiocyanic acid. Zirconium(IV) was eluted from the column with an aqueous ammonium thiocyanate–ammonium sulfate solution, then hafnium(IV) was stripped from the column with aqueous ammonium sulfate or sulfuric acid. (auth)

241 PRECISE MICRODETERMINATION OF URANIUM-235 IN IRRADIATED GRAPHITE FUEL SYSTEMS VIA SHORT-LIVED IODINE FISSION ISOTOPES. Buzzelli, George (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Anal. Chem., 37: 1405-8(Oct. 1965). (GA-6312).

Microgram quantities of ^{235}U in irradiated fuel systems can be accurately determined via neutron activation analysis utilizing the 21-hr ^{133}I fission isotope. Standard iodide carrier containing excess hydrazine as a reductant was added to the sample. The samples, together with uranium reference standards, were irradiated simultaneously. Iodine was separated in a single oxidation extraction step into CCl_4, which was subsequently counted for ^{133}I. The chemical yield of both standards and samples was determined colorimetrically. The precision and accuracy of this method for ^{235}U at the ppM level based on standards are within ±1%. This is a simple, rapid, and sensitive method. Subnanogram quantities of ^{235}U are readily determined by modification of the method, employing the 53-minute ^{134}I fission isotope. (auth)

242 ANALYSIS FOR MICROGRAM QUANTITIES OF THORIUM IN PLUTONIUM, NEPTUNIUM, AND URANYL NITRATE SOLUTIONS. Johnson, W. C. Jr.; Campbell, Milton H. (Hanford Atomic Products Operation, Richland, Wash.). Anal. Chem., 37: 1440-1(Oct. 1965).

Because large sample volumes are required to find the thorium contaminate in gross concentrations of plutonium, uranium, and neptunium, the probable need for a two-cycle purification of thorium was considered. An anion exchange adsorption from a hydrochloric acid matrix was considered for the first cycle gross separation. The final thorium purification would be accomplished by liquid–liquid extraction with TOPO. The chloride complexes of Pu(IV), Np(IV), and the uranyl ion were retained on the ion exchange resin. Thorium was found quantitatively in the column effluent. (M.C.G.)

243 MASS SPECTROMETRIC MEASUREMENT OF ^{18}O IN SMALL CARBON DIOXIDE SAMPLES. Han, InGun; Fritz, George J. (Univ. of Florida, Gainesville). Anal. Chem., 37: 1442-3(Oct. 1965).

Carbon dioxide was analyzed for ^{18}O in a recording mass spectrometer. The atom fraction of ^{18}O in a sample of carbon dioxide was calculated to formulas previously derived by Klein, which describe the atom fraction of ^{18}O as a function of ratios of peak heights 44, 45, 46, 47, and 48. Peak heights were recorded by scanning and normalized for pressure changes. The atom fractions of ^{18}O of the order of 5 at. % and lower could be determined with an accuracy of 0.01 at. % at inlet reservoir pressures of 5 μ or higher. (F.J.H.)

244 TRI-n-OCTYLPHOSPHINE SULFIDE: A SELECTIVE ORGANIC EXTRACTANT. Elliott, Donald E.; Banks, Charles V. (Iowa State Univ., Ames). Anal. Chim. Acta, 33: 237-44(Sept. 1965).

Tri-n-octylphosphine sulfide (TOPS) was investigated as the stationary phase in reversed-phase partition paper chromatographic separations using nitric or hydrochloric acids as the mobile phase. TOPS was also studied as an extractant for metal ions. Silver, mercury(II), and palladium(II) were found to have R_F values of zero when hydrochloric acid was used as the mobile phase. These same ions were also selectively extracted from aqueous nitric acid solutions. Gold(III), mercury(II), palladium(II), and platinum(IV) were found to have R_F values of zero when hydrochloric acid was used as the mobile phase. However, only gold(III) and mercury(II) were extracted from aqueous hydrochloric acid solutions in liquid-liquid extraction systems. Several separations were successfully performed from 1M nitric acid. (auth)

245 THE METHOD OF CONCENTRATION-DEPENDENT DISTRIBUTION IN THE QUANTITATIVE USE OF RADIOISOTOPES. PART I. THEORETICAL CALIBRATION CURVES AND COMPARISON TO THE SUBSTOICHIOMETRIC PRINCIPLE. Kyrs, Miroslav (Czechoslovak Academy of Sciences, Rez). Anal. Chim. Acta, 33: 245-56(Sept. 1965).

The method is based on the utilization of a calibration curve which shows the dependence of the distribution ratio

in a two-phase system containing the substance to be determined or a substance reacting with it, on the total concentration of the substance to be determined. The relationship of the proposed method to radiometric titration and to the substoichiometric principle in isotopic dilution is discussed. Formulas for the theoretical calibration curves in 4 systems are derived: sorption conforming to the Langmuir isotherm or to the Freundlich isotherm, extraction with a constant quantity of an extracting agent, and sorption or extraction in the presence of a constant quantity of a chelating agent. Theoretical sensitivities are given. (auth)

246 X-RAY SPECTROGRAPHIC DETERMINATION OF TANTALUM IN NIOBIUM BY ELECTRON EXCITATION. Toussaint, C. J.; Vos, G. (Euratom, CCR, Ispra, Italy). Anal. chim. Acta, 33: 279-84(Sept. 1965).

An x-ray method is proposed for the determination of tantalum in niobium by direct electron excitation. The optimum excitation conditions for greatest sensitivity are given. The limit of detection for a counting time of 400 sec was found to be 20 ppM. The relative deviation in the 0.4-5% concentration range was ±2%. (auth)

247 DETERMINATION OF LUTETIUM IN AN Al-Lu ALLOY. Brueck, A.; Lauer, K. F. (EURATOM, Geel, Belg.). Anal. Chim. Acta, 33: 338-40(Sept. 1965).

A method is described for the determination of concentrations of over 1% of Lu in Al. The alloy is first dissolved in 6 N HCl and Al is masked with an appropriate amount of aqueous 20% (wt/v) sulfosalicylic acid solution. Any Fe present can be masked with ascorbic acid. The total volume is adjusted to about 100 ml with twice-distilled water. Concentrated ammonia solution (d = 0.9) is added until the pH is about 5, and then adjusted to 5.5 (pH meter) with a dilute (1 : 99) ammonia solution. Ten drops of aqueous 0.2% (wt/v) xylenol orange solution is added and titrated with standard EDTA solution, taking the sharp color change from red to yellow as the end-point. (P.C.H.)

248 THE IODOMETRIC ANALYSIS OF MIXTURES OF HYDROGEN PEROXIDE AND LOWER ALKYL PEROXIDES, WITH PARTICULAR REFERENCE TO THE RADIOLYTIC OXIDATION OF METHANE. Hearne, J. A. (Wantage Research Lab., Berks, Eng.). Anal. Chim. Acta, 33: 344-7(Sept. 1965).

Studies were made on the reactions of potassium iodide with mixtures of hydrogen peroxide, methyl hydroperoxide, dimethyl peroxide, and ethyl hydroperoxide. Beer's law was not obeyed above $[OD]^{1cm} = 0.8$. For measurements below this limit an extinction coefficient $\epsilon = 24600$ was used, and a calibration curve was used for optical densities from 0.8 to 1.7. It was concluded that hydrogen peroxide can be identified and estimated when in admixture with any or all of the above peroxides provided that the dilution of these is not so low as to form additional hydrogen peroxide. (P.C.H.)

249 STUDIES ON THE PRECISE DIFFERENTIAL POLAROGRAPHIC DETERMINATION OF ELEMENTS OF NUCLEAR INTEREST. PART I. DETERMINATION OF EUROPIUM AND YTTERBIUM IN LITHIUM CHLORIDE AND LITHIUM IODIDE ELECTROLYTES. Verdingh, V.; Lauer, K. F. (Central Bureau for Nuclear Measurements, Geel, Belg.). Anal. Chim. Acta, 33: 469-80(Nov. 1965).

Differential polarographic determinations of the Eu and Yb contents of solutions of LiI and LiCl can be made within the concentration ranges of 50 to 500 μg Eu/g with varying precision. Comparative techniques can give precisions of the order of 0.1% or even better; the accuracy depends on the reference material used for the standardization of the method. (auth)

250 DETERMINATION OF NANOGRAM AMOUNTS OF CESIUM BY A CONCENTRATION-DEPENDENT DISTRIBUTION METHOD. Kyrs, Miroslav; Kadlecova, Libena (Czechoslovak Academy of Sciences, Rez). Anal. Chim. Acta, 33: 481-6(Nov. 1965).

Paper impregnated with Prussian blue sorbs cesium in low concentration to a different extent if varying initial concentrations of cesium are present. This dependence can be employed for the determination of submicrogram amounts of cesium. The selectivity and precision of the method are discussed. The method was applied to the determination of specific activity in carrier-free ^{137}Cs samples. (auth)

251 THE TEMPERATURE DEPENDENCE OF THE FADING EFFECT IN SEMIQUANTITATIVE AUTORADIOGRAPHY BY THE RING-OVEN METHOD. Weisz, H.; Klockow, D. (Univ., Freiburg i.B.). Anal. Chim. Acta, 33: 538-42(Nov. 1965). (In German).

In semiquantitative autoradiography used in conjunction with the ring-oven method, a fading effect was found to cause erroneous results, especially for long exposure times. The dependence of this effect on the temperature was studied for several examples (^{45}Ca, ^{204}Tl, and $^{90}Sr/^{90}Y$). It was found that the exposure and storage of the undeveloped autoradiogram at low temperature (<4°) practically eliminated the fading effect. (auth)

252 STUDIES TOWARD THE CHEMICAL IDENTIFICATION AND SELECTIVE DETERMINATION OF RARE EARTHS IN THEIR MIXTURES. Pribil, R.; Vesely, V. (Polarographic Inst. of J. Heyrovsky, Prague). Chem.-Anal., 54: 100-1(Oct. 1965).

A color differentiation test for rare earths was developed based on the competing reactions of the rare earths, with two complexing agents, EDTA and Methylthymol Blue, in ammonia media. All of the rare earth–EDTA complexes reacted with Methylthymol Blue in a slightly ammoniacal medium giving an intense blue color. In a medium 4M in ammonia, yttrium and the rare earths of atomic number 57 to 66 still yield a blue color; in contrast, those of atomic number 67 to 70 do not give any color. Lutetium gives only a slight pink color. The sum of all the rare earths present is determined either by back titration using an excess of EDTA with zinc or by a direct EDTA titration. To the solution resulting from the titration sodium dihydrogen phosphate is added and a titration with zinc started. Certain of the rare earths are quantitatively displaced from their EDTA complexes and precipitated as rare earth phosphates. In the phosphate displacement, the rare earths fall into 3 groups: Group I, those that are quantitatively displaced from EDTA complexes (La, Ce, Pr, and Nd); Group 2, those that are incompletely displaced (Sm, Eu, Gd, Tb, and Dy, and also Y); and Group 3, those that are not displaced at all (Ho, Er, Tm, Yb, and Lu). Rare earths in groups 1 and 3 can easily be determined; where elements in group 1 are present, the EDTA freed is titrated with zinc. However, if rare earths in group 2 are present, the selectivity is lost. The results obtained with several rare-earth mixtures are given. (F.J.H.)

253 MEASUREMENT OF SOFT β-RADIATION IN BIOLOGICAL MATERIAL WITH THE AID OF LIQUID SCINTILLATORS. II. DETERMINATION OF ^{14}C AND ^{3}H BY OXIDATION IN OXYGEN ATMOSPHERE. Franc, Z.; Svobodova, J.; Francova, V.; Lipovska, M.; Horesovsky, C. (Inst. of Clinical and Experimental Surgery, Prague). Collec. Czech. Chem. Commun., 30: 2875-8 (Aug. 1965).

Treatment of biological material before analysis for ^{14}C and ^{3}H by scintillation counting is discussed. An oxidation method was found to be more efficient than the solubilization method. (M.C.G.)

254 MICRO DETERMINATION OF COPPER IN BIOMATERIALS BY NEUTRON ACTIVATION ANALYSIS. Doshi, G. R. (Atomic Energy Establishment, Trombay, Bombay). Current Sci. (India), 34: 478(Aug. 20, 1965).

^{63}Cu has an activation cross section of 4.3 ± 0.2 barns and affords a suitable nuclear reaction $^{63}Cu(n,\gamma)^{64}Cu$ for the estimation of copper in biomaterials. Samples of 20 to 50 mg of ash are irradiated, dissolved in HCl, the copper precipitated, and the precipitate was counted. This method was tested on the ash of marine and freshwater animals. (F.J.H.)

255 AMPEROMETRIC DETERMINATION OF UO_2^{++} AS VANADATE. Mittal, M. L.; Saxena, R. S. (Government Coll., Kota, India). Experientia, 21: 481-2(1965).

A rapid amperometric method for determination of UO_2^{++}

ions is described. It consists of titrating against sodium ortho-vanadate solution at $E_{de} = -0.85v$ (vs SCE). Uranyl contents down to 0.5 mM can be determined with an accuracy of 1%. (F.J.H.)

256 SPECTROCHEMICAL DETERMINATION OF BORON AND STRONTIUM IN REACTOR WATERS. Schoenfeld, I. (Soreq Nuclear Research Centre, Yavne, Israel). Israel J. Chem., 3: 47-55(June 1965). (IA-1016).

An adaptation of the copper-spark excitation method of spectrochemical analysis is presented for determination of boron and strontium in reactor waters. The intensities of the analytical lines BII-3451.41Å and SrII-4077.714Å were determined photometrically and related to the concentrations of B and Sr. The method covers the ranges 5×10^{-7} to 7.5×10^{-6}% and 2.5×10^{-7} to 5×10^{-6}% for B and Sr, respectively. The method was extended to lower concentrations by five superimposed exposures (the limits of detection then being 10^{-7}% for B and 5×10^{-8}% for Sr), and it can be extended even further, when necessary, by use of a greater concentration factor and/or more superimposed exposures. The method is simple and rapid, and yet adequately sensitive and precise. The coefficients of variation for single determinations of B and Sr content are about 10% and 14%, respectively. (auth)

257 MICROHETEROMETRIC METHOD FOR THE DETERMINATION OF VANADIUM WITH 5,7-DIIODO-8-HYDROXYQUINOLINE. Bobtelsky, M.; Gancz, M. (Hebrew Univ., Jerusalem). Israel J. Chem., 3: 57-81(June 1965).

A quick and precise method is given for the heterometric determination of 0.13 to 0.2 mg of vanadium in 20 ml solution, with 5,7-diiodo-8-hydroxyquinoline (diiodoxine). Large amounts of Ca, Mg, Zn, Ni, Co, Cd, Al, Pb, U, and Zr do not interfere with the determination of vanadium. The titration is carried out in 5 to 8 min and the maximum error is about 1%. (auth)

258 MICROESTIMATION OF ZIRCONIUM WITH ^{32}P BY RADIOMETRIC PROCEDURE. Purkayastha, Usha; Maity, H. P. (Saha Inst. of Nuclear Physics, Calcutta). J. Indian Chem. Soc., 42: 419-20(June 1965).

A suitable carrier was found for estimation of zirconium as pyrophosphate with ^{32}P. A known amount of labeled pyrophosphate solution was mixed with the solution containing Zr. A solution of potassium iodide was added. Zirconium pyrophosphate was coprecipitated along with thallous iodide by adding thallous sulfate solution. The contents were centrifuged and a portion of the clear solution was measured by means of a liquid counter. From the loss in activity and a knowledge of the pyrophosphate added, zirconium was computed on the assumption that all the zirconium was carried along with the carrier pyrophosphate. (F.J.H.)

259 DETERMINATION OF PLUTONIUM IN PLUTONIUM OXIDE BY CALORIMETRY. Oetting, F. L. (Dow Chemical Co., Golden, Colo.). J. Inorg. Nucl. Chem., 27: 2151-60(Oct. 1965). (RFP-441).

A twin isothermal calorimeter was constructed to determine the power evolved due to alpha particle decay from a sample of plutonium dioxide thereby constituting a method in which an assay of plutonium by calorimetry is made possible. During the course of this investigation the power from a sample of high-purity plutonium metal consisting primarily of plutonium-239 was measured. The experimental results show the power output for plutonium-239 to be $1.923 \pm 0.002 \times 10^{-3}$ W per gram in good agreement with previous published calorimetric values. This leads to a half-life value of 24,181 ± 25 years for plutonium-239. (auth)

260 THE AQUEOUS CHEMISTRY OF HAFNIUM(IV) SOLVENT EXTRACTION AND ION EXCHANGE STUDIES. Deshpande, R. G.; Khopkar, P. K.; Rao, C. L.; Sharma, H. D. (Atomic Energy Establishment, Trombay, Bombay). J. Inorg. Nucl. Chem., 27: 2171-81(Oct. 1965).

Some aspects of the solution chemistry of hafnium(IV) were investigated by TTA solvent extraction and shallow bed ion exchange resin techniques. The stability constants of hafnium(IV) with chloride (β_1 0.7, β_2 0.48), nitrate (β_1, 0.8), sulfate (β_1 110, β_2 5×10^3), and fluoride (β_1 4.2×10^4) ions were determined and they are all lower as compared to the corresponding zirconium(IV) complexes. The rates of exchange of hafnium species on a cation exchange resin at various molarities in HCl, HNO_3, and $HClO_4$ media were also determined. A model for the variation of diffusion coefficients with acidity is suggested. (auth)

261 METAL COMPLEXES IN SOLVENT EXTRACTION STUDIES. III. PREPARATION AND INVESTIGATION OF BINARY AND TERNARY COMPLEXES. Li, N. C.; Wang, S. M.; Walker, W. R. (Duquesne Univ., Pittsburgh). J. Inorg. Nucl. Chem., 27: 2263-70(Oct. 1965).

Some ternary complexes of the type $M(chelate)_2S_x$ [M = UO_2^{2+}, Cu^{2+}, Zn^{2+}, Ni^{2+}, Co^{2+}, chelate = TTA (thenoyltrifluoroacetone anion), S = TBP (tri-n-butyl phosphate), TBEP (tri-n-butoxyethyl phosphate, TOPO (tri-n-octyl phosphine oxide), 4-me-py (4-methyl pyridine), TPPO (triphenyl-phosphine oxide)] were prepared and investigated. Preliminary work was also carried out with HFacac (hexafluoroacetylacetone anion), TFacac (trifluoroacetylacetone anion), and acac (acetylacetone anion) as chelates. The compounds $Zn(HFacac)_2 \cdot xH_2O$ (x = 1 and 2), $Zn(HFacac)_2(TOPO)_2$, $Cu(HFacac)_2TOPO$, $Co(acac)_2(4\text{-me-py})_2$, $UO_2(acac)_2 \cdot 4\text{-me-py}$, and $UO_2(acac)_2(TPPO)_3$ were also isolated. Solvent extraction studies show that the synergistic extraction of ^{65}Zn depends upon the nature of the chelate and of S. It is suggested that the phenomenon of synergism involves both the stability of $M(chelate)_2 \cdot xH_2O$ and $M(chelate)_2S_x$ and further, that the bonding of S, which is directly to the metal, is weak and comparable to solvation or adduct formation. (auth)

262 A FAST PROCEDURE FOR ISOLATING CARRIER-FREE NIOBIUM FROM MOLYBDENUM. Abecasis, Sara M.; Biraben-Scott, Betsy (Univ. Nacional, La Plata, Argentina). J. Inorg. Nucl. Chem., 27: 2274-5 (Oct. 1965).

A fast and efficient separation of carrier-free Nb from Mo can be effected by using an extraction of a pyrogallol complex into ethyl acetate. The procedure gives a liquid sample of carrier-free Nb in about 20 min. Its radiochemical purity is controlled by measuring gamma spectra; a suitable source for beta spectroscopy in about 1½ hr. (P.C.H.)

263 KINETICS OF ION EXCHANGE IN THE PHOSPHONIC RESIN BIO-REX 63. Heitner-Wirguin, C.; Urbach, V. (Hebrew Univ., Jerusalem). J. Phys. Chem., 69: 3400-4(Oct. 1965).

Exchange of the cations Ca, Cu, UO_2, and Th on the phosphonate resin Bio-Rex 63 was studied. The slow step which determines the rate of exchange of copper and calcium ions is diffusion through the resin particles, while for uranyl and thorium the chemical reaction seems to be the rate-determining step, probably because of the formation of inert complexes with the phosphonic resin. Diffusion coefficients, rate constants, and activation energies for the various cations were calculated. (auth)

264 DEUTERIUM ENRICHMENT BY DUAL TEMPERATURE EXCHANGE REACTION BETWEEN HYDROGEN AND WATER. Sawayanagi, Shoichi; Kurihara, Yasuo. J. Soc. High Pressure Gas Ind., 27: 626-32(Oct. 1964). (In Japanese).

The apparatus consisted of a heater, reaction vessel, cooler, sampling device, and gas circulation pump. The reaction vessel was equipped with a stirrer or porous plate. A catalyst (200-325 mesh, charcoal containing 2% platinum) was suspended in heavy water (about 0.35 D atm %) in the reaction vessel, and hydrogen gas was circulated at a constant rate (Ug). Equations are given for cases of stirring and porous plates. For industrial purposes, a reaction vessel with a porous plate would be advantageous. Economic considerations are presented for the industrial enrichment of deuterium by the procedure. A mechanism that will reduce the resistance of gas-liquid surface and an improvement in the catalyst are required. (TCO)

265 GAS-CHROMATOGRAPHIC DETERMINATION OF THE DEUTERIUM CONTENT (99 to 100 at. percent) IN HEAVY WATER. Jaeger, K. (Gesellschaft fuer Linde's Eismaschinen AG, Hoellriegelskreuth, Ger.). Kerntechnik, 7: 221-4(May 1965). (In German).

Following an outline of various known methods of analysis for the determination of the deuterium content of heavy water, a description is given of a gas-chromatographic determination of a deuterium content of 99 to 100 atomic percent. The analyzer consists of a gas-chromatograph including a reduction furnace built into the carrier gas flow and filled with reduced iron. The carrier gas takes along with it a certain quantity of vapor from the heavy water sample to be analyzed which will be separated into the gaseous components D_2, HD, and H_2, producing iron oxide. This gaseous mixture will be analyzed gas-chromatographically within 20 minutes with an accuracy of ±0.02 atomic percent. (auth)

266 QUANTITATIVE ANALYSIS OF YTTRIUM IN STEEL BY SOLUTION SPECTROGRAPHIC ANALYSIS. Iwata, Hideo; Nagai, Mamoru (Nippon Kohan K. K., Tokyo). Nippon Kinzoku Gakkaishi, 29: 483-7(1965). (In Japanese).

A spectrographic method was applied to the determination of yttrium in steel. The solution technique with a rotating disk electrode was used, because solid standard samples for the spectrographic determination of yttrium were not prepared. Effects of discharge conditions, dissolving acids (HCl, HNO_3, H_2SO_4), and electrodes (graphite, Cu) on the sensitivity and precision of the yttrium spectral line were studied. The result showed the optimum analytical condition to be as follows: Discharge condition, spark (L = 0.8 mH, C = 0.0033 μF; Dissolving acid, (1 + 1)HNO_3; Rotating and counter electrode, graphite, and Line pair, Fe 3205.4/Y 3242.3. The reproducibility of the solution method was 3.9% in terms of the coefficient of variance in the range from 0.01 to 0.7% Y. The Ti content must be less than 0.01%, because Y 3242.3Å is affected by Ti 3242.0Å. If the Ti content is more than 0.01%, another line pair Fe 3659.5/Y 3664.6 can be applied. In this case, however, the reproducibility is worse in some measure than that of Fe 3205.4/Y 3242.3. In solid steel samples the yttrium content was determined by the solution spectrographic method and then by the direct excitation method. It was found that the same excitation conditions as for the solution spectrographic method were available and the sensitivity and precision were almost the same as those for the solution spectrographic method. (auth)

267 ELECTROGRAPHIC DETERMINATION OF MAGNESIUM IN MAGNESIUM ALLOYS AND ZIRCONIUM IN ZIRCONIUM ALLOYS. Shiobara, Yai (Kyoiku Univ., Tokyo). Nippon Kinzoku Gakkaishi, 29: 687-90(1965). (In Japanese).

Rapid electrographic determination of magnesium in magnesium–aluminum or magnesium–nickel alloys and zirconium in zirconium–nickel alloys was carried out. The method consisted of stripping alloy constituents into a filter paper moistened with a supporting electrolyte solution and then measuring the intensity of color developed spectrophotometrically on the paper with color reagent. Suggested electrolyte solutions were 0.5M rochelle salt for magnesium alloys and 0.5M NH_4Cl for zirconium alloys. After electrographic stripping (4 v, 10 ma, 10 sec for magnesium and 20 sec for zirconium) of alloy constituents onto the filter paper coupled with pressure 2 kg per 6.25 cm^2, the filter paper was treated with a saturated ethanol solution of quinalizarin for magnesium and with an ethanol solution of 0.5% alizarin for zirconium to develop the colored pattern to be measured at 560 and 510 mμ, respectively. (auth)

268 TRACE ELEMENTS IN HUMAN HAIR. Bate, L. C.; Dyer, Frank F. (Oak Ridge National Lab., Tenn.). Nucleonics, No. 10, 23: 74-8; 80-1(Oct. 1965).

Trace element concentrations in hair, measured by activation analysis, vary among individuals. But many factors influence the measurements, making them as yet inaccurate for identifying people. Because of the interest in using activation analysis for this purpose a study was begun with the broad objective of measuring trace elements in hair and evaluating their use for forensic applications. The research program was aimed not only at measuring trace elements in the hair from a large number of people but also at explaining the behavior of these elements in hair. With these objectives in mind three studies were undertaken. Mean concentrations of trace elements were measured in hair samples from 99 people. The relative effectiveness of a number of solvents and cleaning procedures for removing surface contamination from hair was measured. The influence of environmental factors on the trace element content of hair was measured because adsorption from these sources may represent a major source of the elements found in hair. The topics discussed are identity establishment, and trace element removal, adsorption, and measurement. The results are also discussed. (J.F.P.)

269 ISOTOPIC ANALYSIS OF OXYGEN BY THE OPTICAL SPECTROSCOPY. Ungureanu, C. Rev. Roumaine Phys., 10: 547-53(1965). (In French).

Primary results obtained in the isotopic analysis of oxygen in the ^{18}O concentration range from 1 to 31% are reported. The methods used are described. The oxygen spectra had a complex fine structure and a small isotopic displacement. There was a different variation of the intensities of the fine structure components with pressure. In order to eliminate isotopic dilution, it was necessary to make the measurements in dynamic regime using a photoelectric spectrometer. The results obtained were compared with those given by a mass spectrometer. The error of the method was between ±8% for 1% ^{18}O and ±2% for 31% ^{18}O. For the experimental measurements oxygen/helium mixtures with a ratio of 1/100 were used. This reduced the quantity necessary for the analysis. It is no longer necessary therefore to transform the oxygen into carbon dioxide or carbon monoxide for isotopic analysis. (tr-auth)

270 ACTIVATION ANALYSIS BY PHOTONEUTRON COUNTING. Juliano, Jose O. Sci. Rev., 6: 8-18(Jan.-Feb. 1965).

A new approach in activation analysis is described. However, the method is not meant to replace the more conventional methods of activation analysis using scintillators and Geiger counters nor does it intend to make chemical separations obsolete. Activation analysis by photoneutron counting can be used in cases where the other methods may have failed in much the same way that conventional activation analysis has been shown to be better than any known method for some specific elemental trace analysis. (P.C.H)

271 RAPID DETERMINATION OF THE RADIOCHEMICAL PURITY OF ORTHOPHOSPHATE-^{32}P. Burianek, J.; Cifka, J. (Staatliches Institut fuer Arzneimittelkontrolle, Prague). Z. Anal. Chem., 213: 1-9 (1965). (In German).

Small quantities of radiochemical impurities in orthophosphate-^{32}P can be determined by thin-layer chromatography. The dependence of R_f values on the water content of the solvent, the layer thickness, the amount of carrier, and the running time as well as the sensitivity of the method were estimated. (auth)

272 ENRICHMENT OF TRITIUM BY DIFFUSION THROUGH PALLADIUM. Charalambus, S.; Goebel, K. (CERN, Geneva). Z. Naturforsch., 20a: 1085-7(Aug. 1965). (In German).

The different diffusion velocities of hydrogen and tritium through palladium open the possibilities of tritium enrichment in the residual gas mixture. The relative diffusion velocity of tritium versus temperature and the enrichment related to the initial and final quantities of the mixture as well as the diffusion temperature are described. (auth)

273 THE EFFECT OF VARIOUS FACTORS ON THE ANODIC PEAK OF URANIUM IN THE METHOD OF AMALGAM POLAROGRAPHY WITH ELECTROLYSIS. Spirin, E. K.; Stromberg, A. G. (Tomsk Polytechnical Inst., USSR). Zh. Anal. Khim., 20: 807-10(1965). (In Russian).

Anodic peaks for uranium were obtained in the method of amalgam polarography in preliminary electrolysis at a high current density. The effects of the current density, the time of electrolysis, the uranium concentration, the electrode shape, and the electrolysis temperature on the uranium anodic peak were studied. It was found that under conditions studied the minimum determinable uranium concentration in the solution is about 0.002 μg/ml. (auth)

274 DETERMINATION OF CERIUM IN MAGNESIUM ALLOYS BY MEANS OF A VANADIUM(II) SALT. Gusev, S. I.; Ketova, L. A. (Perm Medical Inst., USSR). Zh. Anal. Khim., 20: 896-8(1965). (In Russian).

It was found that cerium(IV) can be titrated potentiometrically with a solution of a vanadium(II) salt in the presence of a number of elements. A method was developed for cerium determination in magnesium alloys. (auth)

275 FILTER PHOTOMETER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1313). 3 drawings, 2 photos.

The single-beam, photoelectric colorimeter described is used to measure light absorbed by solutions at selected wavelengths, and to determine the concentration of dissolved substances. Interference filters, with peak transmissions near 50% and half-peak bandwidths of 12 to 14 millimicrons, are used to isolate the wavelengths of choice. The photometer consists of two electrically connected parts. The part placed inside the hot cell was designed for ease of remote manipulation. The amplifier and meter unit, located outside of the cell, are used to indicate the phototube output, and the transformers that supply regulated a-c power for the amplifier, probe, and light source. The absorption-cell compartment accommodates vessels for photometric titrations. (For details, see TID-4100) (M.C.G.)

276 METHOD FOR DISSOLVING URANIUM IN NITRIC ACID. Rateau, Arthur (to Commissariat a l'Energie Atomique; Saint-Gobain Nucleaire). German Patent 1,192,634. May 13, 1965. Priority date June 6, 1962, France.

Metallic uranium is attacked by means of a 1- to 11-N nitric acid containing between 2 and 5 mol/l uranyl nitrate. (Gmelin Inst.)

Inorganic and Physical Chemistry

Refer also to abstract 19.

277 (AERE-R-4942) THE EQUILIBRIUM OXYGEN PRESSURE OVER STAINLESS STEELS AND ITS RELATION TO REACTOR FUEL STABILITY. McIver, E. J.; Teale, S. S. (Atomic Energy Research Establishment, Harwell (England)). June 1965. 30p. Dep.; BIS $0.90; HMSO 4s. 6d.

The equilibrium oxygen pressure over mild and stainless steels was measured using a galvanic cell technique. The oxygen pressure measured is considerably lower than that resulting from an iron oxide layer on pure iron. In the case of mild steel this is due to the carbon reducing the oxide layer, and in the case of stainless steels to chromium concentrating in the oxide layer. Data are also presented on the oxygen pressures over Fe/FeO, Mo/MoO_2, Cr/Cr_2O_3, and $MoO_{2.9}$. (auth)

278 (CONF-650407, pp 814-29) THE INFLUENCE OF PHYSICAL PARAMETERS ON THE ADSORPTION OF ^{131}I BY ACTIVATED CHARCOALS. Billard, F.; Caron, J.; Chevalier, G.; Van Der Meersch, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

After an outline of the means of generating iodine-131 in the gas phase and a brief description of the apparatus used, the experimental results obtained on the trapping of iodine-131 by activated charcoal are analyzed. The efficiency depends concurrently on the relative humidity and the iodine concentration of the air. While it is independent of this concentration in dry air, it does not exceed 50 in moist air, whatever the bed depth. When the concentration is less than 1 mCi/m^3, it increases with the concentrations to reach values close to those obtained in dry air for concentrations of around 1000 Ci/m^3. At the same time, the efficiency of a dust filter with respect to iodine remains very low in dry air whatever the iodine concentration; in moist air this efficiency, which is high at low concentrations, decreases when the latter increases. In addition, if a charcoal bed is divided into several beds, separated by an amount corresponding to a passage time of about a second, it is found that the efficiency of the whole is appreciably higher than that of the initial bed. These results appear to establish the existence of at least two forms of iodine, one molecular form and one particulate form probably formed by clusters, the equilibrium forms being functions of the relative concentrations of iodine and water vapor in the air. The third form, a gaseous compound, remains hypothetical; the experimental curves can be explained either by the molecular and particulate forms reversibility or by the increase of clusters size with the relative humidity of the air. (auth)

279 (CONF-650407, pp 853-68) THE REMOVAL OF METHYL IODIDE FROM REACTOR EFFLUENT GASES. Collins, D. A.; Taylor, R.; Taylor, L. R. (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). (TRG-Report-982).

When fission product iodine is released from uranium dioxide fuel elements into carbon dioxide or into steam, some of it is found in the form of methyl iodide. Methyl iodide is relatively unreactive and will penetrate many of the trapping materials that can be used for elemental iodine, but it can be held on activated carbon if the conditions are right. The removal of methyl iodide from dry air or carbon dioxide in the range from room temperature to 100°C can be accomplished without difficulty by a coal-based carbon, provided a certain loading of methyl iodide on the carbon is not exceeded. A coconut-based carbon behaves similarly at 100°C, although breakthrough occurs at a lower loading. At room temperature, however, unacceptable breakthrough occurs at all loadings on coconut carbon after only a short delay due to physical adsorption. Retention on both coconut and coal-based carbons is seriously affected by high humidity, and a number of commercially available carbons have been tested without finding one which gives satisfactory performance in these conditions. Performance can be restored by preheating the humid gas stream so that the relative humidity is reduced below 30% at the carbon, but this is not a particularly attractive solution. A method was found for chemically impregnating coal-based carbon so that it continues to exhibit excellent retention of methyl iodide in air at 100% relative humidity. Work is in progress to define the operating limits of this type of charcoal. (auth)

280 (CONF-650407, pp 869-84) REMOVAL OF IODINE AND VOLATILE IODINE COMPOUNDS FROM AIR SYSTEMS BY ACTIVATED CHARCOAL. Adams, Robert E.; Browning, William E. Jr. (Oak Ridge National Lab., Tenn.).

The behavior of methyl iodide and iodine vapor against four types of activated charcoal under varying degrees of temperature and humidity was investigated. The charcoals were selected to represent four types of this material: bituminous coke, petroleum residue, coconut shell, and a metal-impregnated bituminous coke. Under dry conditions (relative humidity <3%) and at room temperature, all the charcoal types are effective against methyl iodide and iodine vapor. Under wet conditions (relative humidity approximately 75%) and at room temperature, all the charcoal types were effective against elemental iodine but relatively ineffective against methyl iodide. The efficiency for methyl iodide retention ranged from 50 to 97%, with coconut charcoal producing the higher efficiency. Under low humidity and high temperature (100 or 150°C), all charcoal types had high efficiencies for retention of both elemental iodine and methyl iodide. Under steam conditions, at temperatures ranging from 95 to 130°C, the efficiency of the charcoals for methyl iodide is quite low, ranging from 5 to 78%. The efficiency for elemental iodine is also reduced slightly under these conditions, averaging about 98%. (auth)

281 (CONF-650407, pp 1096-1109) SAMPLING AND CHARACTERIZATION TECHNIQUES USED IN THE STUDY OF IODINE RELEASE FROM IRRADIATED FUEL ELEMENTS. Collins, D. A.; Taylor, R.; Yuille, W. D. (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)).

A number of methods of fission product characterization are reviewed and their application in a program of experimental releases of fission products from irradiated uranium dioxide is discussed. The main emphasis in this work is on iodine release and the principal characterization device is the "May" pack which is designed to distinguish between elemental iodine vapor, iodine adsorbed on particulate aerosols, and less reactive vapor compounds of iodine. Additional techniques are used to obtain more information about the several fractions into which the iodine release is classified by the May pack. The less reactive vapor compounds are examined by gas chromatography and also by molecular effusion techniques. The iodine which attaches itself to particulate aerosols derived from the molten cladding material is examined for particle size distribution by thermal precipitators and for its partition behavior between gas and water. Experience is also being gained in the technique, used by Castleman, of classifying the less volatile iodides by means of the temperature at which they deposit, without chemical reaction, on the walls of a tube. The application of these techniques has shown that, when iodine is released from stainless steel or Zircaloy-clad UO_2 at high temperature, whether in carbon dioxide or in steam, the largest fraction attaches itself to solid particles derived from the molten cladding material. The chemical nature of this iodine is being further studied but most of it appears to be in a form that is readily soluble in water. A small, but important, fraction is found as methyl iodide in releases into steam atmosphere as well as into carbon dioxide. (auth)

282 (CONF-650407, pp 1131-61) IDENTITY, CHARACTER, AND CHEMICAL BEHAVIOR OF VAPOR FORMS OF RADIOIODINE. Browning, W. E. Jr.; Adams, R. E.; Ackley, R. D.; Davis, M. E.; Attrill, J. E. (Oak Ridge National Lab., Tenn.).

A program of investigation is being conducted on the identification of radioiodine vapor forms which are likely to occur in reactor accidents, and, where necessary, to investigate the chemical and physical properties of unidentified vapor forms of radioiodine. Data accumulated through application of several analytical tools and techniques such as gas chromatography, mass spectrometry, and measurements of molecular effusion and diffusion rates have demonstrated the presence of methyl iodide, hydrogen iodide, and propyl iodide in systems containing elemental iodine. Methods for distinguishing and measuring forms of gasborne radioiodine are under development. In the composite diffusion tube, various iodine forms are distinguished by measuring the rates at which they diffuse through gases and by observing simultaneously their chemical affinities for various materials such as silver, rubber, and charcoal. The response of composite diffusion tubes was studied, using known vapors of elemental iodine and methyl iodide. The results indicate that elemental iodine deposits in silver-lined diffusion tubes and that methyl iodide flows through the silver-lined tube and deposits in the activated carbon-lined tube. Deposition profiles of those iodine compounds which deposit on rubber in composite diffusion tubes indicated that: (1) at least two compounds are probably involved; (2) the deposition behavior is complex and not solely diffusion controlled; (3) one of the compounds may be unstable, and, in part, the deposition profile may be the manifestation of its decomposition products; and (4) at 0°C the bulk of the species has an indicated vapor pressure about 1% that of iodine. The behavior of volatile iodine in a May pack, as indicated by composite diffusion tubes, was observed in tests with dry and with moderately moist air, to be substantially consistent with the designed functions of the May pack components. Elemental iodine was collected by the copper gauze with an estimated efficiency of 99% in the dry case and 99.9% in the moist case. Studies were performed to determine the extent of reactions at 24°C between iodine and some organic vapor sources. One of the organic sources consisted of a mixture of lubricating oil, plastics, and rubber insulating material, and a second source was dioctylphthalate. The results show appreciable conversion of iodine to other forms took place. The presence of an unknown material, as well as traces of methyl iodide and HI, was detected when iodine vapor was contacted with oxidized mild steel at 100°C in the presence of a reducing steam atmosphere. (auth)

283 (COO-1140-129) THERMODYNAMICS OF VAPORIZATION OF NUCLEAR MATERIALS AT HIGH TEMPERATURES. Gilles, Paul W. (Kansas Univ., Lawrence. Dept. of Chemistry). June 28, 1965, Revised Aug. 9, 1965. Contract AT(11-1)-1140. 33p. (CONF-650704-33; SM-66/72). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From IAEA Symposium on Thermodynamics, Vienna.

Vaporization studies are one of the best, most convenient, and most important ways of obtaining thermodynamic properties and phase relationships of refractory nuclear materials. Measurements are made on equilibrium systems involving at least two phases. The properties of these phases are established by the proportions of the components, the properties of the pure components and their interaction parameters. Free energy-composition curves for the gas phase and the several possible condensed phases in a system are discussed in relationship to one another. The overwhelming effect of pressure on the free energy of the gas phase and the minute effect on condensed phases are pointed out. The relationship between the free energy-composition curves and the vaporization behavior of the system is described. The several factors which are important in establishing free energy-composition curves and, hence, the mode of equilibrium vaporization are discussed. They include the stability of the gaseous molecules, the absolute and relative stabilities of the various condensed phases, the composition of the gaseous molecules, the composition of the condensed phases, and the free energies of sublimation of the elements. A few of the principles associated with congruent vaporization processes and mass spectrometric measurements are discussed. (auth)

284 (EUR-804.e) ELECTRODE OVERVOLTAGES IN MOLTEN FLUORIDES. III. THE ANODIC BEHAVIOUR OF NICKEL ELECTRODES IN MOLTEN KF–NiF_2, KF–NaF–LiF, KF–NaF AND KF–LiF MIXTURES. Pizzini, S.; Morlotti, R.; Roemer, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 1965. 25p. (CONF-650502-4). Dep. mn.

From Electrochemical Society, San Francisco.

Anodic overvoltage measurements on nickel electrodes in molten NiF_2–KF, LiF–NaF–KF, NaF–KF, and LiF–KF eutectic mixtures were carried out by means of the galvanostatic, potentiostatic, and potential sweep method at temperatures ranging from 450 to 800°C. It was observed that, in presence of traces of oxides, added to the melts as NiO or resulting from the hydrolysis of the residual water in the melt after a high vacuum drying process, nickel behaves as a "Deckschicht Elektrode" under different experimental conditions, which depend on the initial $pO^{=}$ of the melt. The influence of the semiconductive behavior of non-stoichiometric NiO surface layers was considered and the results of the present work are compared with the literature data on the Ni/NiO electrode in molten salts. (auth)

285 (EUR-2496.e) OSCILLOGRAPHIC POLAROGRAPHY OF OXYGEN IONS IN MOLTEN NITRATES. Francini, M.; Martini, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 32p. (CONF-650502-10). Dep. mn.

From Electrochemical Society, San Francisco.

A polarographic investigation of the effect of oxide and hydroxyl ions and oxygen gas additions to the molten KNO_3–$NaNO_3$ and $LiNO_3$–$NaNO_3$–KNO_3 mixtures in the temperature range 160-260°C was carried out by single sweep polarography. A dropping mercury electrode was the cathode and an Ag/AgCl electrode acted as reference. The oxide and hydroxyl ions exhibit wave heights linear concentration. The hydroxyl ion is demonstrated to be the

only Red. species participating at the electrode reaction and by electroöxidation gives rise to an Ox. species soluble and diffusing in the mercury. The peak potential of the hydroxyl wave lies in the range +0.100 ± −0.450 volts vs. the reference electrode depending on the $LiNO_3$ molar fraction of the solvent, and this peak potential variation is correlated to the variation of its activity coefficient. The association constants at different temperatures as well as the Helmoltz free energy changes of association are evaluated. (auth)

286 (NRL–6233) HIGH-TEMPERATURE PROPERTIES OF POTASSIUM. Ewing, C. T.; Stone, J. P.; Spann, J. R.; Steinkuller, E. W.; Williams, D. D.; Miller, R. R. (Naval Research Lab., Washington, D. C.). Dec. 11, 1964. 92p. CFSTI $3.00 cy, $0.75 mn.

An experimental program is in progress to measure various thermophysical properties of sodium, potassium, and cesium. A final reporting of the experimental results for potassium (saturation and superheat properties of the vapor, density, and specific heat of the liquid) is presented together with a thermodynamic treatment of the data. Two equations of state are advanced, one virial and one quasi-chemical, and additional saturation and superheat properties of the vapor are derived from these equations. Either of two paths can be used in deriving absolute thermodynamic properties, the monomeric gas path or the liquid path, but results obtained by the former procedure are believed to be more accurate. Enthalpy, entropy, specific volume, specific heat, and compositional information (weight fraction of dimer, weight fraction of tetramer, and average molecular weight) are tabulated for some 800 selected vapor states in the temperature range from 1400 to 2525°F and in the pressure range from 0.2 to 35 atm. (auth)

287 (ORNL-P–1611) THE RESEARCH MATERIALS PROGRAM AT THE OAK RIDGE NATIONAL LABORATORY. Cleland, J. W. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 33p. (CONF-650939–1). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From 2nd International Symposium on Hyperpure Products in Science and Technology, Dresden.

The Research Materials Program was established to develop the necessary techniques required for the production of ultrahigh purity and controlled impurity research specimens (usually single crystal). The choice of potential materials was made on the basis of the gain to a fundamental understanding of solids, and specific requests. These requests included previously uninvestigated materials, and varied techniques of purification and crystal growth were applied to these. Examples of initial purification, crystal growth, and final characterization and analysis are presented for molten salt solvent crystal growth studies of ThO_2, float-zone growth of single crystal grains of UO_2 up to 5 cm long by 0.5 cm diameter, prepurification and Czochralski growth of large (300 gram) single crystals of KCl, and modified Stockbarger growth of single crystals of LiF of varying isotopic composition. (auth)

288 (ORNL-TM–1264) THERMODYNAMIC CALCULATION OF THE YIELD OF URANIUM NITRIDE DURING CARBOTHERMIC REDUCTION OF URANIUM OXIDE IN THE PRESENCE OF PURE NITROGEN OR NITROGEN MIXED WITH HYDROGEN OR INERT GAS. Gens, T. A. (Oak Ridge National Lab., Tenn.). Sept. 16, 1965. Contract W-7405-eng-26. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Calculations based on published free energy data indicate that the equilibrium yields of uranium nitride per mole of nitrogen introduced over heated uranium dioxide and carbon increase from 6×10^{-9} mole to 0.13 mole as the temperature increases from 1000 to 2000°K. The introduction of either hydrogen or inert gas causes the yield per mole of nitrogen to increase slightly. There is no significant difference between the effects of hydrogen and inert gas on yields. The results of these calculations are being used to guide the laboratory preparation of microspheres of UN. (auth)

289 (TID–21358) THE NEAR ULTRAVIOLET SPECTRA OF SOME o-HYDROXY AROMATIC SCHIFF BASES. II. SPECTRA OF THEIR COPPER(II) COMPLEXES. (Pittsburgh Univ., Pa. Dept. of Chemistry). [1963]. Contract AT(30-1)-2274. 17p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Hückel molecular orbital calculations were carried out for bis(N-methylsalicylaldimine)copper(II), bis(N-salicylideneaniline)copper(II), and bis(N-4-methoxybenzylidene-o-hydroxyaniline)copper(II) to aid in the interpretation of the spectra of the complexes. These results were compared with the spectra of a series of Schiff bases in order to determine the possible effects of metal-ligand π-bonding. The ultraviolet and infrared absorption spectra suggest that the extent of metal-ligand π-bonding is not great. (auth)

290 (UCRL–11997) OPTICAL TECHNIQUES FOR THE STUDY OF PHASE BOUNDARIES. Muller, Rolf H. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1965. Contract W-7405-eng-48. 127p. (CONF-650118–1). Dep. mn; CFSTI $4.00 cy, $0.75 mn.

From Gordon Research Conference on Electro Chemistry, Santa Barbara, Calif.

Principle, capability, and limitation of certain optical techniques suitable for the study of surfaces and boundary layers are discussed. Techniques considered are: interferometry, flow tracing, Schlierenoptics, ellipsometry, and film interference. (auth)

291 (UCRL–14379) RELATIONSHIP BETWEEN CHEMICAL BONDING AND THE X-RAY SPECTRUM: STUDIES WITH THE SULFUR ATOM. Wilbur, David Wesley (Lawrence Radiation Lab., Univ. of California, Livermore). Aug. 1965. Contract W-7405-eng-48. 107p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

Changes in the x-ray spectrum caused by chemical bonding are discussed and theories relating these changes to the electronic charge on the involved atoms are reviewed with particular emphasis on the emissions of the third-period elements. Such changes were studied experimentally on the sulfur atom in pure sulfur and 17 sulfur-containing compounds ranging from inorganic and organic sulfides to sulfates. Measurements were made using a plane, single-crystal, helium path spectrometer with proportional counter and pulse-height analysis for detection and Soller slits for collimation. The sulfur K_β intensities and K_α energies were determined for the range of compounds and changes with bonding were compared in an effort to establish better their usefulness as indicators of chemical state. The K_α line, whose intensity is essentially unaffected by chemical bonding, was used as an internal intensity standard for the K_β line to minimize errors in the matrix correction, which was required to remove the effects of sample composition from the K_β intensity. For the compounds studied, K_β intensity and K_α energy showed an approximately linear relationship for the higher sulfur valences but within the 0 and −2 valence states they had no particular correlation; however, the sulfides as a group had higher K_β intensities and lower K_α energies than the higher valence states of sulfur. The energies and intensities were both determined relative to those of pure sulfur. The observed K_α energy extremes were As_2S_2 at −0.119 ev and Na_2SO_4 at +1.200 ev with an average standard deviation of ±0.004 ev for the K_α energies. The K_β/K_α intensity ratio extremes were As_2S_2 at 1.253 and Na_2SO_4 at 0.989 relative to the pure sulfur ratio and the estimated average uncertainty was about ±0.5% for the intensity ratios. Both the K_β line energies and widths exhibited large differences over the range of compounds studied, but there was no obvious correlation with bonding. A K_β spectrum line about 13 ev lower in energy than the main K_β emission was observed only in the 5 compounds of highest sulfur valence which had at least 2 oxygen atoms bonded to the sulfur atom. The intensity of this line was found to be negatively correlated with that of the main K_β emission, reaching a maximum of one-third of the main K_β intensity in Na_2SO_4. (auth)

292 (UCRL–16173) HIGH TEMPERATURE CHEMICAL ENGINEERING RESEARCH IN NUCLEAR TECHNOLOGY. Olander, Donald R.; Camahort, J.; Pasternak, A. (Lawrence Radiation Lab., Univ. of California, Berkeley). June 1965. Contract W-7405-eng-48. 25p. (CONF-650938–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 2nd International Congress on Chemical Engineer Automation and Machinery, Prague.

Kinetic experiments were conducted on possible volatility and pyrometallurgical systems for high-temperature reprocessing of spent fuels. The reaction $UCl_4 + Cl_2 \rightarrow UCl_6$ was studied in Li–KCl eutectic at 400–700°C. The equilibrium constant was determined to be ln K = 2.65 – 2730/T, and results of kinetic runs using a wetted rod contactor are compared with theoretical predictions. A study was made of single-drop extraction of solute metals (^{140}La and ^{140}Ba) between two immiscible liquid metal solvents (Mg and U–Cr eutectic). Small U–Cr pellets were irradiated, cooled, and then lowered into liquid Mg to form molten droplets. Droplet velocities were measured, and the drag coefficients were compared with the correlation for aqueous–organic systems. Mass transfer coefficients were calculated from the fraction extracted, velocities, and pellet size. The low external mass transfer coefficients suggest an irreproducible interfacial resistance. (D.L.C.)

293 (UCRL–16330) SOLUBILITIES, CONDUCTANCES, VISCOSITIES AND DENSITIES OF SOLUTIONS OF SELECTED INORGANIC COMPOUNDS IN DIMETHYL SULFOXIDE [Thesis]. Melendres, Carlos A. (Lawrence Radiation Lab., Univ. of California, Berkeley). Sept. 1965. Contract W-7405-eng-48. 68p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Studies on physical and electrochemical properties of solutions of inorganic salts in dimethyl sulfoxide (DMSO) are presented to further characterize this compound as a solvent for electrochemical systems. Data are given on the solubility of a number of salts in DMSO at 25°C, together with the conductivities, viscosities, and densities of the saturated solutions, at the same temperature. With some notable exceptions, the data presented are in reasonable agreement with some values that have appeared in the literature. The accuracy of the solubility data given is estimated to be about ±2%. A number of salts formed solid coordination compounds with the solvent. Their empirical formulas are given as determined by elemental analysis. The effect of added LiCl on the solubility and conductivity of saturated solutions of other salts was explored as a means of increasing solubility and conductivity through salt effects or complex formation in solution. A considerable increase in the solubility of some salts was observed and was attributed to complex formation. The conductivities of the binary salt solutions are higher than the specific conductivities of the corresponding single salts in DMSO. (auth)

294 (UCRL-Trans-1239(L)) STUDY OF THE ENERGIES OF THE METAL-HYDROXYL BONDS IN MOLECULES CaOH, SrOH, AND BaOH. Ryabova, V. G.; Gurvich, L. V. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Teplofiz. Vysokikh Temperatur, Akad. Nauk SSSR, 3: 318-21(1963). 14p. Dep. mn; CFSTI $1.00 cy, $0.50 mn; JCL $1.60 fs, $0.80 mf.

The CaOH, SrOH, and BaOH bonds were studied by means of reactions of Ca, Sr, and Ba with the combustion products of H_2–air flames. The partial pressures were measured at 1760 to 2160°K using $SrCl_2$, $BaCl_2$, and $Ca(CH_3COO)_2$ in eight H_2–air flames. The partial pressure data indicate considerable hydroxide formation in the flame. Individual Me–OH bond energies were determined to be 100 ± 8, 95 ± 8, and 111 ± 8 kcal/mole for CaOH, SrOH, and BaOH, respectively. (D.L.C.)

295 POLAROGRAPHY OF URANYL-MALATE COMPLEXES AT MODERATELY LOW TEMPERATURE. Lai, Tsai-teh; Wey, Song-jey (Cheng Kung Univ., Tainan, Taiwan). Anal. Chim. Acta, 33: 324-9(Sept. 1965).

The polarographic behavior of uranyl ion at the dropping mercury electrode was examined in malic acid solution at 15°C. The limiting regions of complex formation, polymerization, and reversibility as functions of pH value and ligand concentration were studied. The dimerization of the complexes was demonstrated by the current-voltage curves and conductometric measurements. Three kinds of complex species with metal-ligand ratio of 2 : 1, 2 : 2, and 2 : 3 were identified. (auth)

296 HOMOGENEOUS REDOX REACTIONS IN SULFATE-ION-CONTAINING SOLUTIONS. III. $U^{IV}/U^{(VI)}$ SYSTEM. Baechmann, K.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Ber. Bunsenges. Physik. Chem., 69: 522-8(1965). (In German).

In the system U^{IV}/U^{VI} in the absence of light the rate of the electron exchange in solutions containing sulfate ions was measured at different temperatures using ^{233}U as a tracer. Under these conditions the rate was proportional to the concentrations of U^{IV} and U^{VI} and inversely proportional to the third power of the H^+-concentration. The rate determining step of the electron exchange was the disproportionation of U^V (present in small quantities, in equilibrium, with U^{IV} and U^{VI}). The rate constant for the electron exchange in a solution containing sulfate ions was 1.3×10^{-4} $l^2 \cdot mol^{-2} \cdot sec^{-1}$ (25°C, ionic strength 2); this rate constant was higher than the rate constant in a solution containing perchlorate ions by a factor of about 600. For the activation energy 10.2 kcal/mol were found. (auth)

297 SULFUR ISOTOPE EFFECTS IN THE HYDROGEN ION DECOMPOSITION OF THIOSULFATE. Agarwala, U.; Rees, C. E.; Thode, H. G. (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 43: 2802-11(Oct. 1965).

Sulfur isotope effects in the decomposition of thiosulfate were studied. There are two distinct intermolecular isotope effects and these were used to examine various mechanisms for the reaction. By use of the theory of competing isotope reactions the thiosulfate decomposition mechanisms of La Mer and Davis are shown to predict isotope effects not in accord with experiment, while a simple bimolecular three-centered reaction is shown to predict sulfur and sulfite isotope effects in good agreement with the experimentally determined values of 1.9% and 0.9%. (auth)

298 DETERMINATION OF THE CRYSTAL STRUCTURE OF ERBIUM TITANATE, $Er_2Ti_2O_7$, BY X-RAY AND NEUTRON DIFFRACTION. Knop, Osvald (Dalhousie Univ., Halifax, N. S.); Brisse, Francois; Castelliz, Lotte; Sutarno. Can. J. Chem., 43: 2812-26(Oct. 1965).

The crystal structure of erbium titanate, $Er_2Ti_2O_7$, was shown by x-ray and neutron powder diffraction to be of the cubic pyrochlore type, with $a_0 = 10.0762 \pm 6$ Å. Least-squares isotropic refinement based on resolved single reflections gave $x(O_2) = 0.4200 \pm 10$ and R = 2.25%. Ionic and neutral x-ray scattering factors gave practically identical results. The six equal Ti–O_2 distances in the distorted coordination octahedron of the Ti atom are 1.955 ± 5 Å. The two short (apparent) Er–O distances are 2.1815 ± 5 Å (Er–O_1) and 2.471 ± 8 Å (Er–O_2). The infrared spectrum of the titanate in the region 1,600 to 250 cm^{-1} showed features similar to those encountered in the spectra of other simple oxygen compounds of titanium. (auth)

299 CHLORIDE AND SULFATE ION ASSOCIATION WITH SOME LANTHANIDE AND ACTINIDE IONS. Manning, P. G. (Dept. of Mines and Technical Surveys, Ottawa). Can. J. Chem., 43: 2911-13(Oct. 1965).

The experimental and calculated ratios for stepwise stability constants for two stages of ion association for rare earth chlorides and sulfate are given and discussed. Ion pair calculations were performed assuming that chloride binds at the octahedral edge of a 6-hydrated cation and at the corresponding dodecahedral edge of an 8-hydrated cation. Data indicated that both the chlorides and sulfates are ion pairs. (F.J.H.)

300 VIBRATIONAL FREQUENCY PERTURBATIONS IN THE RAMAN SPECTRUM OF HYDROGEN. May, A. D.; Poll, J. D. (Univ. of Toronto). Can. J. Phys., 43: 1836-42(Oct. 1965).

The influence of the lattice vibrations on the shift of the vibrational Raman lines in solid hydrogen and the influence of nonadditive intermolecular forces on the shift in hydrogen gas are investigated for freely rotating molecules in terms of the adiabatic approximation. It is shown that the experimental value for the shift in the solid can be accounted for by introducing a reasonable value for the amplitude of the lattice vibrations. The effect of the nonadditive intermolecular forces on the shift in hydrogen gas is shown to be appreciable at high densities. (auth)

301 PROTON MAGNETIC RESONANCE SPECTRA OF PYRIDINE N-OXIDE, 4-SUBSTITUTED PYRIDINE N-OXIDES AND THEIR COMPLEXES WITH URANYL CHLORIDE. Kanekar, C. R. (Tata Inst. of Fundamental Research, Bombay); Venkatasetty, H. V. Current Sci. (India), 34: 555-6(Oct. 5, 1965).

The proton resonance spectra of pyridine N-oxide, 4-methoxypyridine N-oxide, 4-methylpyridine N-oxide, and 4-nitropyridine N-oxide and of their complexes with uranyl chloride are described. These compounds were dissolved in deuterated dimethylsulfoxide and the proton chemical shifts were measured in ppm relative to the protons in dimethylsulfoxide as an internal standard on the spectrometer. There was a correlation between infrared and NMR data for these complexes. (M.C.G.)

302 NEW COMPOUNDS OF RARE EARTHS WITH STRONTIUM AND BARIUM OXIDES. Bkhargava, Kh. D.; Kovba, L. M.; Martynenko, L. I.; Spitsyn, Vikt. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 161: 594-6(Mar. 21, 1965). (In Russian).

A series of compounds of the $SrLn_2O_4$- or $BaLn_2O_4$-type were synthesized by calcining at 1100 to 1300°C compacted mixtures of variable ratios of corresponding oxides or salts. Reactions between strontium oxide and rare earths and between barium oxide and certain rare earths were studied by x-ray phase analysis of the reaction products. Strontium oxide was shown to form $SrLn_2O_4$ compounds with all rare earths from neodymium to lutetium, at a rate decreasing with increasing ionic radius of the rare earth element. Barium oxide reacted with the rare earths from praseodymium to lutetium, i.e., formed $BaLn_2O_4$ compounds with the elements having a greater ionic radius than those reacting with the strontium oxide. All synthesized compounds, except $BaYb_2O_4$, crystallized in the rhombic system with a $CaFe_2O_4$-type structure. The lattice parameters of all $(Sr,Ba)Ln_2O_4$ compounds were tabulated. Apparently, $BaYb_2O_4$ crystallized in the hexagonal system and displayed an ordered arrangement of heavy atoms, forming a superstructure. The reaction between SrO and Sm_2O_3 was singled out because of a significant solubility of SrO in Sm_2O_3 at 1700°C, which confirmed the possible existence of an extended homogeneity region (β form) in Sm_2O_3. Formation of the $(Sr,Ba)Ln_2O_4$ compounds is explained as manifestation of the amphoteric property of the rare earths. All of the compounds, except $SrYb_2O_4$ were found to be stable at room temperature in the presence of water vapor, moist, or dry CO_2. (CFSTI)

303 NEW COMPOUNDS OF THE RARE EARTHS WITH LITHIUM. Sevost'yanova, N. I.; Murav'eva, I. A.; Kovba, L. M.; Martynenko, L. I.; Spitsyn, Vikt. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 161: 1359-61 (Apr. 21, 1965). (In Russian).

Four compounds of rare earths with lithium oxide were prepared and analyzed by x rays to supplement study of the amphoteric character of the rare earths. Two compounds were prepared by calcining at 500 to 800°C compacted mixtures of Pr_2O_3 or Tb_2O_3 and lithium carbonate. Since x-ray powder patterns of the products were similar to the previously described patterns of $LiNdO_2$ or $LiGdO_2$, it was possible to assign the compounds the formula $LiPrO_2$ or $LiTbO_2$. Lithium terbate ($LiTbO_2$) crystallized in the rhombic system with lattice constants: a = 5.27, b = 11.16, and c = 3.41 Å. The crystal structure of $LiPrO_2$ was different but could not be determined from its x-ray pattern. The compounds $LiLaO_2$ and $LiYbO_2$ were prepared by calcining mixtures of the nitrates of corresponding rare earth elements with lithium nitrate. $LiLaO_2$, in disagreement with the earlier data, crystallized in the rhombic system and had a distorted cubic unit cell. The lattice parameters of $LiLaO_2$ were determined. The earlier reported crystal structure of $LiYbO_2$ was confirmed. (CFSTI)

304 ISOTOPIC EXCHANGE OF CYCLOBUTANE WITH DEUTERIUM ON EVAPORATED METAL FILMS. Gudkov, V. S.; Balandin, A. A.; Savin, E. P. (Inst. of Inorganic Chemistry, Academy of Sciences, SSSR). Dokl. Akad. Nauk SSSR, 162: 843-6(June 1, 1965). (In Russian).

Deuterium exchange was studied over evaporated films of Pt, Pd, Ni, W, and Mo at 0 to 171°C, using a mass spectrometer. The cyclobutane ring was relatively stable toward hydrogenolysis (none was observed for Pt). No break in continuity in the transition from $C_4H_4D_4$ to $C_4H_3D_5$ was observed for any of the above metals. A rise in temperature had little effect on the distribution of the products of deuterium exchange, causing only an increase (Mo, Pd, Ni) or decrease (W) in the degree of hydrogenolysis of cyclobutane relative to the isotope exchange. The data indicated that the lack of screened neighboring C–H bonds, located on both sides of the plane of the ring, did not prevent the propagation of the exchange. The fact that the maximum on the distribution curve for cyclobutane was absent both in the case of metals with a fcc lattice (Pt, Pd, Ni) and in the case of metals with bcc lattice (W, Mo) may be regarded as a confirmation of the structural tenets of the multiplet theory. There was no structural correspondence between cyclobutane and these metals, in contrast to the correspondence existing between cyclohexane and Pt, Pd, and Ni. The rate of hydrogenolysis of cyclobutane relative to the rate of deuterium exchange increased in the order Pt, Pd, and Ni. (CFSTI)

305 LATTICE CONSTANTS OF SOME ALKALI METAL ACTINYL(V) COMPOUNDS. Keenan, T. K. Inorg. Chem., 4: 1500-1(Oct. 1965).

Lattice constants for cesium americyl(V) carbonate, rubidium neptunyl(V) fluoride, rubidium plutonyl(V) fluoride, ammonium plutonyl(V) fluoride, and rubidium americyl(V) fluoride are given. Methods of preparing these compounds are described. (F.J.H.)

306 ISOTOPE EFFECTS IN BORON HYDRIDES. X. THE REACTION OF DIBORANE WITH BASIC D_2O. Davis, Robert Earl; Gottbrath, Judith Ann (Purdue Univ., Lafayette, Ind.). Inorg. Chem., 4: 1512-13(Oct. 1965).

The reactions of borane (or diborane) with heavy water were studied. In this way information could be obtained on the isotope effect in the acid hydrolysis of sodium borohydride. Diborane was passed into solutions of 0.1M sodium deuterioxide at 4°C in heavy water of 99.62% isotopic purity. The excess water was removed and the powdery residues were added to borate buffers in a large excess of light water. The evolved gases were analyzed for deuterium. Essentially all of the hydridic hydrogens were found to arise from the diborane (F.J.H.)

307 HYDRATION OF RARE-EARTH TUNGSTATES. Borchardt, Hans J. J. Amer. Ceram. Soc., 48: 495-6 (Sept. 21, 1965).

It is shown that hydrates of stoichiometry $R_2(WO_4)_3 \cdot 3H_2O$ exist which have not been reported before. The hydration phenomenon was first noted in connection with a destructive transformation in single crystals of $Y_2(WO_4)_3$. The hydration process occurs very rapidly. Within an hour after growth, cloudiness can be detected in the crystal. X-ray studies showed that tungstates of Ho, Er, Tm, Yb, Lu, and Y form trihydrates, whereas the other rare earth tungstates either do not, or at least do not form them rapidly. (P.C.H.)

308 INFRARED SPECTRA OF ANHYDROUS RARE-EARTH NITRATES FROM 4000-100 cm^{-1}. Walker, A.; Ferraro, J. R. (Argonne National Lab., Ill.). J. Chem. Phys., 43: 2689-92(Oct. 15, 1965).

The infrared spectra of the anhydrous rare-earth nitrates are presented in the region 4000-100 cm^{-1}. Strong coordination of the nitrate groups to the metal atom occurs. Possible different types of metal-oxygen bonding in these compounds are discussed. (auth)

309 MAGNETIC CHARACTERISTICS OF COMPOUNDS OF CERIUM AND PRASEODYMIUM WITH V-A ELEMENTS. Tsuchida, T.; Wallace, W. E. (Univ. of Pittsburgh). J. Chem. Phys., 43: 2885-9(Oct. 15, 1965).

The magnetic behavior of CeP, CeAs, CeSb, PrP, PrAs, and PrSb was investigated over the temperature range extending from 4° to 300°K. Curie–Weiss behavior is observed for all compounds in the upper portion of the temperature range studied with effective moments in fair agreement with those expected for the free tripositive ions. The cerium compounds have Néel points at temperatures ranging from 8° to 25°K. The praseodymium compounds give no evidence of magnetic ordering. At low temperatures they exhibit the Van Vleck temperature-independent paramagnetism. This is attributed to the influence of the crystal field in splitting the ninefold degenerate ground state of the free Pr^{3+} ion. The susceptibility-temperature behavior of PrSb can be accounted for in terms of a single parameter from which an over-all crystal field splitting of 157 cm^{-1} is deduced. Similar attempts for PrP and PrAs were unsuccessful, presumably because of the increased importance of nonlinear shielding effects in these materials. The results for CeP and CeAs indicate partial quadrivalency of Ce in these compounds. Results for CeSb are very complex; indications are that this compound orders in several stages. (auth)

310 CHLORINE–OXYGEN NUCLEAR SPIN-SPIN SPLITTING IN ClO_4^- ION IN AQUEOUS SOLUTION. Alei, Mohammed Jr. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 43: 2904-6(Oct. 15, 1965). (LA-DC-7242).

Observations of a quantity of ^{17}O-enriched ClO_4^- ions were made with the Varian DP-60 spectrometer. The ^{17}O spectrum of ClO_4^- enriched to 1.77% in ^{17}O is shown. The derivative of the dispersion signal was recorded with a modulation amplitude of about 10-mG peak-to-peak compared with the individual component linewidth at a half height of about 70 to 80 mG, thus providing excellent resolution of spectral features. The spin-spin coupling constant was measured at 8 and at 6 Mc, and confirmed that the four peaks shown are indeed due to spin-spin splitting of equivalent oxygen nuclei by the central chlorine nucleus. The spectrum of ^{17}O in ClO_3^- is also shown. The oxygen in this radical was enriched to about 2.6% in ^{17}O. The spectrum was recorded at 8.13 Mc with the same instruments and under the same conditions used in recording the ClO_4^- spectrum. The single line ^{17}O spectrum of ClO_3^- was observed at the same position relative to the ^{17}O resonance in H_2O as the center of the ^{17}O four-line resonance in ClO_4^-. (J.F.P.)

311 INFRARED SPECTRA AND INTENSITY ENHANCEMENTS IN SOLUTIONS OF HYDROGEN HALIDES IN LIQUID XENON. Goldring, H.; Kwok, J.; Robinson, G. W. (Calif. Inst. of Tech., Pasadena). J. Chem. Phys., 43: 3220-8(Nov. 1, 1965).

The intensities and shapes of the vibrational fundamental bands of HCl, HBr, and HI dissolved in liquid xenon at 165°K were examined at the resolution of a Beckman IR-7. While no rotational fine structure was observed, rotational branch maxima were exhibited in all three cases. The spectra of the dissolved molecules are different from those of the gaseous molecule in that they exhibit strong Q branch and probably also O and S branches. This observation should be compared with spectra of hydrogen halides in dense gases where a Q branch is prominent, and with spectra of such molecules in solid rare gases where ordinarily a strong Q branch is not produced. The extended selection rules in the liquid are probably caused by anisotropic fields which are capable of mixing J states. In this sense, the rotational motions of the hydrogen halides in liquid xenon are not "free." The large intensity enhancements, 2.8 for HCl, 3.1 for HBr, and 44 for HI, are inadequately explained on the basis of dielectric polarization effects. Nuclear distortion effects on the intensity enhancements are shown to be negligible. It was concluded that electronic distortion effects must account for the enhancement. A semiquantitative description based on the lowering of ionic states of the hydrogen halides in the presence of the dielectric medium indicates that for each of the halides studied about one-sixteenth of an electron moves from the proton to the halogen when the molecule is dissolved. This is sufficient electronic distortion to account for the intensity enhancement in all three molecules. This increased ionicity should manifest itself not only in infrared intensity enhancements but also in permanent dipole moment corrections for dissolved polar molecules. The permanent moment corrections may exceed those given by the Onsager dielectric theory. (auth)

312 EXCHANGE REACTIONS WITH ACTIVATION ENERGY. I. SIMPLE BARRIER POTENTIAL FOR (H,H_2). Karplus, M.; Porter, R. N.; Sharma, R. D. (Columbia Univ., N. Y.). J. Chem. Phys., 43: 3259-87(Nov. 1, 1965).

A quasiclassical procedure for the examination of the collision dynamics of atom–diatomic-molecule reactions with activation energy is introduced. By means of Monte Carlo averages over a large number of appropriately chosen three-dimensional classical trajectories, the total reaction cross section (S_r) and other reaction attributes can be determined as a function of the initial relative velocity (V_r) and the initial molecular rotation-vibration state (J,v). The method was applied to the exchange reaction resulting from a hydrogen atom and a hydrogen molecule moving on a simple barrier potential of the London–Eyring–Polanyi–Sato type. It was found that S_r is a monotonically increasing function of relative velocity that arises smoothly from a threshold at $\sim 0.9 \times 10^6$ cm/sec to its asymptotic value of $\sim 4.5 a_0^2$ at $\sim 1.8 \times 10^6$ cm/sec. The zero-point vibrational energy of the molecule contributes to the energy required for reaction, but the rotational energy does not. The reaction probability, which depends on V_R, v, and J, was found to be a smoothly decreasing function of the impact parameter (b) with a maximum of ~0.6 for b = 0 at high velocities. By integration of S_r over the distributions of V_R, v, and J corresponding to temperatures between 300 and 1000°K, a rate constant that can be fitted to an expression of the form $K(T) = AT^{\alpha} \exp[-E_{\alpha}^0/RT]$ was obtained, where A, E_{α}^0, and α ($\alpha = 1.1762$) are constants. This temperature dependence was analyzed and contrasted with the results obtained from an absolute rate theory treatment based on the same surface. A detailed examination of the collision trajectories showed no evidence for a long-lived "collision complex"; instead the results are best represented by a direct interaction model with an interaction time on the order of that required for the atom to pass unimpeded by the molecule. For reactive collisions, the transition configuration is nonlinear with average angles of 170° for $V_R = 0.93 \times 10^6$ cm/sec and 150° for $V_R = 1.30 \times 10^6$ cm/sec; for nonreactive collisions, the average angle is between 95 and 125°, but has no simple relation to V_R. (auth)

313 ON THE USE OF THE LANGEVIN EQUATION OF BROWNIAN MOTION FOR THE ANALYSES OF COLD AND SLOW NEUTRON SCATTERING BY LIQUID METHANE. Griffing, George W. (Phillips Petroleum Co., Idaho Falls, Idaho). J. Chem. Phys., 43: 3328-36(Nov. 1, 1965).

The Langevin equation of Brownian motion was used to analyze the experimental data on the scattering of cold and slow neutrons by liquid methane. Scattering of neutrons by a molecule in the liquid was treated analytically as for a gas except the translational mode of the molecule was assumed to obey the Langevin equation. To obtain agreement with the experimental data using this model, it was necessary to adjust the viscous damping coefficient η appearing in the Langevin equation as the magnitude of the momentum transfer κ in the collision between the neutron and the molecule changes. Plotting the value of η needed to best fit the observed quasielastic peak against the momentum transfer κ resulted in a straight line on a semilogarithm plot. An extrapolation of the straight line to zero momentum transfer gave a value of 1.7×10^{13} sec^{-1} for the viscous damping coefficient. This value is in agreement with the experimental value of the diffusion coefficient which is related to the viscous damping coefficient by the

Einstein relation. It is pointed out that the analysis is, at least qualitatively, in accord with results on the scattering of neutrons by other liquids. There is evidence, although not conclusive, that the rotational motion is partially hindered. (auth)

314 HYPERFINE SPIN-SPIN INTERACTION IN H_2^+. Somerville, W. B. (Univ. of London Observatory). J. Chem. Phys., 43: 3398-9(Nov. 1, 1965).

Calculation of the hyperfine spin-spin dipole interaction coefficient for H_2^+ in the ground state was carried out and the results were compared with previous results. It was found that difference between the two methods used was small. (P.C.H.)

315 ANOMALOUS DEUTERIUM HYPERFINE SPLITTINGS. Jones, M. T.; Cairncross, A.; Wiley, D. W. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Chem. Phys., 43: 3403-4(Nov. 1, 1965).

Hyperfine splittings in the perdeuterotropyl radical, the anion radicals of perdeuterobenzene and 1,4-dideuteronaphthalene were compared with the usual hydrogen-containing radical. The results showed that those radicals characterized by strong electronic-vibrational interactions display large anomalies as compared with less symmetrical aromatic anion radicals such as naphthalenide. Interpretation of the results is discussed. (P.C.H.)

316 ORGANIC COMPOUNDS OF LANTHANIDE ELEMENTS. PART IV. ALCOHOLATES OF PRASEODYMIUM AND NEODYMIUM CHLORIDES. Mehrotra, R. C.; Misra, T. N.; Misra, S. N. (Univ. of Rajasthan, Jaipur, India). J. Indian Chem. Soc., 42: 351-8(June 1965).

The reactions of anhydrous praseodymium and neodymium chlorides were studied with different alcohols (methanol, ethanol, isopropanol, and n-butanol) and compounds of the type $MCl_3 \cdot 3ROH$ were isolated. Their trichloride monohydrates yielded compounds with the general formula $MCl_3 \cdot H_2O \cdot 2\,ROH$. The higher alcoholates could also be synthesised from lower alcoholates by alcohol-interchange technique. The conductances of alcoholic solutions of anhydrous praseodymium chloride in methanol and ethanol were measured. A spectrophotometric study of neodymium chloride trialcoholates (methanol, ethanol, and isopropanol derivatives) was made. (auth)

317 THERMAL DECOMPOSITION OF OXALATES OF LANTHANUM AND THORIUM IN VACUUM. Srivastava, O. K.; Vasudeva Murthy, A. R. (Indian Inst. of Science, Bangalore). J. Indian Inst. Sci., 47: 87-96(July 1965).

Thermal decomposition of hydrated oxalates of lanthanum and thorium was studied in vacuum in two ways: by heating the same sample to higher temperatures progressively and collecting and analyzing the gaseous product in the specified temperature range and by taking different samples each time and heating to the predetermined temperature, then collecting the gaseous product as well as the solid residue and analyzing them. The gaseous product contained carbon monoxide and carbon dioxide. The residue contained any undecomposed oxalate, basic carbonate of the metal or its oxide, and elemental carbon. A mechanism for the decomposition is suggested on the basis of the intermediate formation of a metallic carbonate. (auth)

318 REFLEXION SPECTRA OF UO_2 PREPARED FROM U_3O_8 CALCINATED UNDER VARIOUS CONDITIONS. Imris, P.; Imris, D. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). J. Inorg. Nucl. Chem., 27: 2135-49(Oct. 1965).

Reflection spectra of UO_2 with a specific surface of 0.5–6 m^2/g prepared by reduction of U_3O_8 calcinated at temperatures from 610 to 1000°C under various time conditions are described. The reflection spectra of UO_2 with a specific surface of 7–12 m^2/g prepared by direct reduction of ammonium diuranate (ADU) with H_2 through the intermediate stage of UO_3, and annealed in H_2 at 500, 700 and 900°C are presented for the purpose of comparison. The relation between the reflection spectra and the size of particles measured by means of sedimentation analysis was studied for all samples. Reflection spectra of various sizes of particles of the same sample of UO_2 as fractions separated by sedimentation are also indicated. The reflection spectra of UO_2 were also studied in relation to aging. The aim of the study was to establish a relation between the properties and sizes of particles of UO_2 prepared under various conditions, and the reflection spectra. The change in the intensity of absorption bands at wavelengths of 460, 520, 600, and 690 nm was examined in the spectra of all samples of UO_2 and U_3O_8. It was found that the intensity of absorption bands depended on the crystalline properties of UO_2 at wavelengths of 460 and 520 nm, while at 600 and 690 nm it depended on the oxygen index of UO_2. (auth)

319 THE EFFECT OF TARTARIC ACID ON THE KINETICS OF THE OXIDATION OF URANIUM(IV) BY THALLIUM(III) IN AQUEOUS PERCHLORIC ACID. Love, C. M.; Quinn, L. P.; Brubaker, C. H. Jr. (Michigan State Univ., East Lansing). J. Inorg. Nucl. Chem., 27: 2183-92 (Oct. 1965). (COO-1001-4).

The kinetics of the oxidation of uranium (IV) by thallium (III) in the presence of tartaric acid was investigated in aqueous perchloric acid solutions. Increases in initial rate with increasing tartaric acid concentrations were observed, along with departure from the second-order rate law. The orders with respect to uranium (IV), thallium (III), tartaric acid, and hydrogen ion were found to be 0.93, 0.05, 0.37, and −0.91, respectively. Thallium (III) in the presence of tartaric acid was shown to be stable by polarography, yet in kinetics experiments with Tl(III) in excess over uranium (IV), the reaction stopped because the Tl(III) was consumed. The oxidation of U(IV) by oxygen of the air is catalyzed by the presence of tartaric acid, but this reaction is negligibly slow compared to the U(IV)–Tl(III)–tartaric acid reactions. The presence of U(VI), and Tl(I) were found to have no effect on the reaction kinetics. A mechanistic interpretation was developed to account for the observed results. (auth)

320 A STUDY OF SOME BIGUANIDE COMPLEXES OF RHENIUM(V). Ray, M. M. (Indian Association for the Cultivation of Science, Calcutta). J. Inorg. Nucl. Chem., 27: 2193-7(Oct. 1965).

Rhenium(V) in combination with biguanide as ligand, has a pronounced tendency to form multiple bonds with oxygen. A series of complexes containing such bonds, of the type $[ReO(OH)(BigH)_2] \cdot OH \cdot X$ (X = OH, CH_3COO, Cl, $\frac{1}{2}SO_4$; BigH = one molecule of biguanide, $C_2N_5H_7$, in the Zwitterion form) is described. The configurations, magnetic properties, and infrared spectra are discussed. (auth)

321 URANIUM(IV) NITRATE AND PERCHLORATE SPECIES IN TRI-n-BUTYL PHOSPHATE SOLUTIONS. Woodhead, J. L.; McKay, H. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 27: 2247-54(Oct. 1965).

Seven different uranium (IV) species were identified in tri-n-butyl phosphate (TBP) solutions by their absorption spectra. In nitrate media, in addition to the neutral complex $U(NO_3)_4 \cdot (TBP)_2$, found in the range 0.2–1.5 M nitric acid, there is: a hydrolyzed species, $UOH(NO_3)_3(TBP)_x$, formed in the absence of added nitric acid; a species containing $U(NO_3)_8^{4-}$ formed when lithium nitrate is present; and a species containing the U^{4+} ion solvated with TBP and probably electrostatically associated with nitrate which occurs in TBP solutions containing >4 M nitric acid. The equilibrium constant at 20° of the reaction, $[U(NO_3)_4 + H_2O \rightleftharpoons UOH(NO_3)_3 + HNO_3]_{TBP}$ is 0.035 ± 0.005. In perchlorate media three species with different absorption spectra are formed. One is not hydrolyzed and exhibits a spectrum very similar to that of U^{4+} in aqueous solution; the others are hydrolyzed and have OH/U ratios of 1 and 2, respectively. (auth)

322 THE THERMODYNAMICS OF THE SCANDIUM–HYDROGEN SYSTEM. Lieberman, M. L.; Wahlbeck, P. G. (Illinois Inst. of Tech., Chicago). J. Phys. Chem., 69: 3514-19(Oct. 1965). (COO-1029-6).

Isothermal equilibrium hydrogen pressure measurements were made as a function of composition for the scandium–

hydrogen system in the temperature range 600.9 to 1052.6°C and up to a hydrogen pressure of 1 atm. The data indicate the existence of two solid solution ranges; the first extends to about $ScH_{0.55}$, and the second can be described as a scandium hydride phase deficient in hydrogen with respect to ScH_2. The solubility boundaries defining the immiscibility interval between these two solid solution phases were evaluated; for this two-phase region the hydrogen pressures were found to obey log P (mm.) = $-[(10{,}477 \pm 93)/T] + (10.409 \pm 0.087)$. The relative partial molal and integral thermodynamic properties were calculated. Marked changes with composition of the relative partial molal enthalpy and entropy of hydrogen were noted in the first solid solution region. (auth)

323 URANIUM MONOSELENIDE. HEAT CAPACITY AND THERMODYNAMIC PROPERTIES FROM 5 TO 350°K. Takahashi, Yoichi; Westrum, Edgar F. Jr. (Univ. of Michigan, Ann Arbor). J. Phys. Chem., 69: 3618-21(Oct. 1965).

The low temperature heat capacity of USe was determined by adiabatic calorimetry and found to have a normal sigmoid temperature dependence except near the 160.5°K transition from the ferromagnetic to the paramagnetic state. The heat capacity (C_p), entropy (S^0), enthalpy function ($[H^0 - H_0^0]/T$), and Gibbs energy function ($-[G^0 - H_0^0]/T$) at 298.15°K in cal/(gfm °K) are 13.10, 23.07, 10.39, and 12.68, respectively. (auth)

324 INFRARED BAND WIDTH OF THE NITRATE ION ν_2 MODE. IONIC LIFETIMES AND A SOLVENT ISOTOPE EFFECT. Evans, J. C.; Lo, G. Y-S. (The Dow Chemical Co., Midland). J. Phys. Chem., 69: 3650-2(Oct. 1965).

Ammonium nitrate solutions were chosen as reference system in order to determine the band width of an infrared absorption band of a long-lived nitrate ion in surroundings which, except for possibility of the exchange reaction, resemble closely those existing in nitric acid solution. The results of the infrared band-width measurements for ammonium nitrate solutions show a slight concentration dependence indicating that the NH_4^+ is not without some effect upon the solvent shell or upon the nitrate ion directly. A reasonable extrapolation yielded a value of 10.4 ± 0.5 cm^{-1} for the nitrate ion band width in dilute aqueous solution. In 3N HNO_3, the band width is 12.5 ± 0.5 cm^{-1}. The lifetime of the ion is approximately 3.2×10^{-11} sec. An isotope ratio of about 1.5 is in accord with the view that reactions of this type are diffusion-controlled reactions whose rates are determined by the exceptionally high mobilities of the proton and deuteron in aqueous solution. Raman data for the ν_1 nitrate mode, near 1050 cm^{-1}, yielded essentially the same result for the nitrate ion lifetime. Solvent isotope effects of deuterium on the 830 cm^{-1} infrared band are discussed. (P.C.H.)

325 SLOW NEUTRON SCATTERING BY CH_3OH AND CH_3SH MOLECULES. Borowski, Feliks (WAT, Warsaw); Rzany, Henryk. Nukleonika, 10: 201-6(1965).

The total neutron scattering cross sections in the thermal energy range were measured for liquid and gaseous methyl alcohol and methyl mercaptan. The results obtained are compared with theory. (auth)

326 THE INFLUENCE OF DISPROPORTIONATION REACTION OF U(V) IONS ON OSCILOPOLAROGRAPHIC WAVES OF U(VI) REDUCTION AND U(V) OXIDATION IN ORGANIC ACID SOLUTIONS. Sobkowska, Aleksandra (Inst. of Nuclear Research, Warsaw). Nukleonika, 10: 229-37(1965). (In Polish).

The oscillographic waves measurements of U(VI) → U(V) reduction and U(V) → U(VI) oxidation in perchlorate and in presence of ascorbic, lactic, acetic, and tartaric acid solutions were carried out. These measurements were performed for various rate of potential change and pH in order to estimate the influence of U(V) disproportionation on the course of oscillographic waves. (auth)

327 RADIOMETRIC DETERMINATION OF ION SELF-DIFFUSION MOBILITIES. II. ION BINDING IN POLYELECTROLYTE SOLUTIONS. Dorabialska, Alicja; Plonka, Andrzej (Technical Univ., Lodz, Poland). Nukleonika, 10: 287-96(1965).

Tracer transfer rate coefficients were measured in electrolyte and polyelectrolyte solutions by the radiometric method. The degree of ion binding in polyelectrolyte solutions was determined assuming additivity of tracer transfer rate coefficients. (auth)

328 THE KINETICS OF U(V) IONS DISPROPORTIONATION IN ORGANIC ACID SOLUTIONS. Sobkowska, Aleksandra; Minczewski, Jerzy (Inst. of Nuclear Research, Warsaw). Nukleonika, 10: 311-20(1965).

The kinetics of the disproportionation of U(V) ions in presence of organic acids was investigated. It was established that the rate of this reaction depends on the nature of the organic acid, its concentration, and the concentration of hydrogen ions. The results were confirmed qualitatively by polarographic measurements. (auth)

329 INVESTIGATION OF EVAPORATION OF LANTHANUM HEXABORIDE. Gordienko, S. P.; Samsonov, G. V.; Fesenko, V. V. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 2, 70-3(Aug. 1965). (In Russian).

A mass spectrometric investigation of the evaporation process of lanthanum hexaboride showed that the vapor, effusing from a Knudsen cell consists chiefly of atomic lanthanum. The ratio of ion currents $I^+_{La^{139}} : I^+_{B^{11}}$ at a temperature of 2100°K was 1 : 0.007. The heat of sublimation of LaB_6 at the mean temperature of the experiments, 2200°C, determined by the second law of thermodynamics, was estimated as 536 ± 8.7 kg/mol. A rise in the emissive power of the tungsten cathode was noted on powdering lanthanum on it. (auth)

330 ^{13}C NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. Stothers, J. B. (Univ. of Western Ontario, London). Quart. Rev. (London), 19: 144-67(1965).

Experimental technics of ^{13}C nuclear magnetic resonance (NMR) spectroscopy are reviewed, and salient results obtained with this method are surveyed (63 references are cited). Up to the present, rapid-passage dispersion mode conditions using liquid samples have been employed for most studies of natural abundance ^{13}C NMR spectra. In general, conventional high resulution absorption mode operation leads to saturation of the absorbing nuclei because of the high radiofrequency power required for detection of weak signals. Typical results and the basic features of the dispersion mode technique are illustrated. Useful improvements have arisen from recent developments in double resonance technics whereby more than one nucleus is excited simultaneously through the use of two (or more) radiofrequencies. An application of the double resonance method for observing weak spectra has been developed, employing two frequency synthesizers in combination with a proton-stabilized, frequency-sweep spectrometer. The method, internuclear double resonance spectroscopy, is an important advance but the cost of the instrumentation required will hinder its general application. To illustrate the general behavior of ^{13}C nuclei in various organic molecules some specific results are outlined, after which a discussion of the findings and applications of these is presented. It was concluded that the major obstacle to widespread use of ^{13}C spectroscopy is the need for increased sensitivity. (TCO)

331 RECENT DATA ON THE VAPOR PRESSURES OF THE METALS AND OF SOME REFRACTORY METALLOIDS. PART II. Trombe, Felix; Caro, Paul; Blaise, Michele. Rev. Hautes Temp. Refractaires, 2: 115-36 (Apr.-June 1965). (In French).

Information on the vapor pressures of the following elements is presented: Ti, Hf, Zr, Th, C, Si, Ge, Sn, Pb, V, Nb, Ta, Sb, Bi, Cr, Ir, Pt, Mo, W, U, Se, Te, Po, Mn, Re, Fe, Ni, Co, Ru, Rh, Pd, and Os. (97 references). (M.C.G.)

332 SOLID SOLUTIONS FORMED BY THE ADDITION OF SULPHIDES OF THE RARE-EARTHS TO FACE-CENTRED CUBIC (TYPE NaCl) MS SULPHIDES. Patrie, Madeleine; Flahaut, Jean; Domange, Louis (Faculte de Pharmacie, Paris). Rev. Hautes Temp. Refractaires, 2: 187-98(Apr.-June 1965). (In French).

The systems formed at 1200°C between L_2S_3 rare earth

sulfides and MS sulfides were studied (where M = Mg, Ca, Sr, Ba, or Mn). With MgS and MnS, fcc (Type NaCl) solid solutions were obtained from the sulfides. The extent of the homogeneity fields was directly proportional to the difference between the radii of the ions replacing each other, and increased from samarium to lutetium. With CaS, solid solutions also formed with the last rare earth elements but not with the first; this was contrary to what would be expected from the ionic radii, but was in agreement with the usual coordination of the rare earths in their L_2S_3 sulfides. The solid solutions, starting from the NaCl type structure, showed two superstructures, which appeared progressively, without discontinuity, when the rare earth content increased. One was fcc with a parameter double that of the fundamental lattice, the other was rhombohedral with the angle progressively decreased by the addition of L_2S_3 from its value of 60°, which is characteristic of the cubic system. (auth)

333 ANALYTICAL APPLICATION OF FLUORINE ION. II. FUSING AGENTS TO MELT AND DECOMPOSE THE MINERALS OF THORIUM. Seki, Jisuke (Inst. of Physical and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 37: 470-4(1961). (In Japanese).

Studies showed that sodium hydrogen fluoride and ammonium hydrogen fluoride can be used as fusing agents in decomposition of thorium ore. These not only make the decomposition take place more readily, but also make the operations after the decomposition much easier (separation from other elements, solvent extraction of thorium, etc.). Investigations of the individual properties of these two fluorides and potassium hydrogen fluoride as fusing agents are reported. (TCO)

334 ON THE CRYSTAL STRUCTURE OF $LiUO_3$. Kemmler, Sibylle (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem., 388: 9-14(July 1965). (In German).

$LiUO_3$ crystallizes rhombohedrally with $a = 5.90_1$ Å and $\alpha = 54° 36'$, $Z = 2$, space group C_{3v}^6–R3c ($LiNbO_3$ structure). (auth)

335 INELASTIC SCATTERING OF LOW-ENERGY ELECTRONS ON METHANE, PROPANE, AND n-HEPTANE. Ehrhardt, H.; Linder, F.; Meister, G. (Universitaet, Freiburg i. B.). Z. Naturforsch., 20a: 989-97(Aug. 1965). (In German).

The inelastic scattering of 70 ev electrons (0.3 ev half width) by methane, propane, and n-heptane was measured in the angular range of 0 to 145°. From these data the relative total cross sections versus energy loss of the electrons for propane and n-heptane are calculated. The energy distributions of the scattered electrons and the electrons ejected during the ionization processes are largely separated. In the case of n-heptane the ratio of the total number of processes leading to neutral excited states and the total number of processes leading to ionized states is determined. About 25% of the neutral excitations have energies below the first ionization potential, 75% above. Electronic levels of the ionized species are observed; some of them have been predicted by MO calculations. The amount of vibrational energy transferred to one electronic state is discussed, and the rapid change of the form of the energy transfer function with temperature (from 50 to 850°C) is experimentally demonstrated. (auth)

336 SUBSTITUENT EFFECTS ON SECONDARY DEUTERIUM ISOTOPE RATE EFFECTS [Thesis]. Buddenbaum, Warren Edward. Bloomington, Ind., Indiana Univ., 1964. 130p.

The equivalent conductivity of hydrochloric acid in 50, 90, and 95 volume per cent ethanol-water and in 80, 93, and 95 volume per cent acetone-water mixtures at 25°C was determined. A computer program was written for the IBM-709 for fitting the conductance data to the Fuoss-Onsager conductance equation. Appreciable ion association was found for the acid in 93 and 95 per cent acetone. A computer program was written for the least squares calculation of the first-order rate constant for the solvolysis of an alkyl halide from conductance data. In this program allowance was made for the non-ideal behavior of the ions. The least squares time and resistance residuals can also be calculated. The sensitivity of the rate constants to errors in the conductance parameters was determined using synthetic data. These calculations suggest a method for approximating the conductance parameters needed for kinetic determinations. The α- and β-secondary deuterium isotope rate effects on the solvolysis of substituted 1-phenylethyl chlorides and bromides and on substituted benzhydryl chlorides in acetone-water and ethanol-water mixtures were measured with precise conductance techniques with a precision of 0.1%. The influence of solvent, substituent, and leaving group on these effects was interpreted in terms of an incursion of some nucleophilic character in the substitution. The markedly different sensitivity of the α- and β-effect to the above variables is discussed in terms of the usually suggested causes for secondary deuterium isotope rate effects. (Dissertation Abstr.)

337 SOME POLYNUCLEAR TANTALUM HALIDES AND THEIR OXIDIZED DERIVATIVES [Thesis]. Hughes, Benjamin Glenn. Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 84p.

The preparation and characterization of several derivatives of the polynuclear tantalum halide ions, $Ta_6Cl_{12}^{2+}$ and $Ta_6Br_{12}^{2+}$, was studied. The crystalline hydrates, $(Ta_6Cl_{12})Cl_2 \cdot 10H_2O$ and $(Ta_6Br_{12})Br_2 \cdot 8H_2O$, were prepared by evaporation of aqueous solutions of $Ta_6Cl_{12}^{2+}$ and $Ta_6Br_{12}^{2+}$ in vacuo. They were found to yield spectra in aqueous solution which were very similar and apparently characteristic of the Ta_6X_{12} unit. Extinction coefficients for observed visible and ultraviolet absorption maxima are given. A two electron oxidation for the $Ta_6Cl_{12}^{2+}$ and $Ta_6Br_{12}^{2+}$ ions was found and determined quantitatively. Insoluble oxidation products formed in aqueous sulfate solution were identified as $Ta_6Cl_{12}(SO_4)_2 \cdot 7H_2O$ and $Ta_6Br_{12}(SO_4)_2 \cdot 7H_2O$. Both gave infrared absorption spectra indicative of coordination of the sulfate group. The tetrahalide derivatives, $(Ta_6Cl_{12})Cl_4 \cdot 9H_2O$ and $(Ta_6Br_{12})Br_4 \cdot 5H_2O$, were prepared and identified by analysis. They gave ultraviolet and visible reflectance spectra strikingly similar to the disulfates and dihalides. Magnetic susceptibility data for the disulfates, $(Ta_6Cl_{12})(SO_4)_2 \cdot 7H_2O$ and $(Ta_6Br_{12})(SO_4)_2 \cdot 7H_2O$, obeyed the Curie law with magnetic moments of 0.4 μ_B for the chloride and 0.6 μ_B for the bromide. Susceptibility data for the dihalides, $(Ta_6Cl_{12})Cl_2 \cdot 10H_2O$ and $(Ta_6Br_{12})Br_2 \cdot 8H_2O$, obeyed the Curie law with moments of 0.4 μ_B for the chloride and 0.5 μ_B for the bromide. The temperature independent paramagnetism was $+270 \times 10^{-6}$ emu/mole for the chloride and $+330 \times 10^{-6}$ emu/mole for the bromide. (Dissertation Abstr.)

338 ACTIVITY-COMPOSITION RELATIONS IN SOME OXIDE AND ALLOY PHASES AT ELEVATED TEMPERATURES. Muan, A. (Pennsylvania State Univ., University Park). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-66/74, 20p. (CONF-650704-25). ORINS.

From IAEA Symposium on Thermodynamics, Vienna.

Activity-composition relations in oxide and metal solid and liquid solutions were determined at 800 to 1400°C. Oxides with periclase-, spinel-, olivine-, and pyroxene-type structures, and binary metal systems formed by combination of Pt or Pd with one of the elements Fe, Co, Ni, Mn, Cr, or Pb were considered. Oxide systems studied included CoO–MgO, CoO–MnO, NiO–MgO, NiO–MnO, "FeO"–MgO, and "FeO"–MnO of periclase-type structure, Co_3O_4–Mn_3O_4, Co_3O_4–Fe_3O_4, and Fe_3O_4–Mn_3O_4 of spinel-type structure, Fe_2SiO_4–Mn_2SiO_4 of olivine-type structure, and $FeSiO_3$–$MnSiO_3$ and $FeSiO_3$–$MgSiO_3$ of pyroxene-type structure. Metal systems studied include Pt–Fe, Pt–Co, Pt–Ni, Pt–Mn, Pt–Cr, Pt–Pb, and Pd–Fe, Pd–Co, Pd–Ni, Pd–Cr, Pd–Pb. Stability relations of the various oxides, and the availability of reliable phase equilibrium data for the substances involved, are discussed as a basis for proper selection of composition ranges and phase assemblages on which to make the equilibrium measurements. Three different experimental techniques are described: EMF, thermogravimetric, and quenching techniques. Advantages and disadvantages of each technique are

discussed, in terms of the temperature range involved and on the nature of the system being studied. Examples of application of each of the three methods to specific systems are given. (auth)

339 DIFFUSION AND INTERACTIONS IN THE URANIA–TUNGSTEN AND URANIA–MOLYBDENUM SYSTEMS. Kaznoff, A. I.; Sanderson, M. J. (General Electric Co., Pleasanton, Calif.). 9p. (CONF-650908-6). ORINS.

From International Conference on Thermionic Electrical Power Generation, London.

Urania-tungsten and urania-molybdenum systems were studied. The stability of urania with tungsten and molybdenum was shown for periods up to 10,000 hr at thermionic design temperatures. A comparison of alpha-counting and mass spectrometric results indicated that contamination of targets by sublimates of tungsten and molybdenum did not affect the determination of uranium by alpha counting. A reasonable trend was observed in increasing diffusion rates with increasing temperature for tungsten. A test was designed to check the diffusion rates in arc-cast tungsten and to obtain confirmation of the cycling effect. This conformation was obtained in the step function decreased to 1600°C. It was established in all tests that the fuel becomes hypostoichiometric: $UO_2(s) \rightarrow UO_{2-x}(s) + (x/2)O_2$. The oxygen was lost either as elemental oxygen or as metal oxides, by diffusion and volatilization from the capsule. The hypostoichiometric phase was unstable with respect to urania and uranium. The elemental uranium could then dissolve in the cladding and produce higher concentration gradients. These gradients increased with time to give the high peak rates of diffusion. Depletion of the uranium-precipitated source caused a decay of the diffusion flux. The actual diffusion flux started at a high rate of 8.2×10^{-8} g/hr-cm^2 and leveled out during the last 700 hr to 2.75×10^{-9} g/hr-cm^2. The results of tests in the molybdenum-urania system showed that diffusion rates at 1600 to 1750°C were comparable to those in the W-UO_2 system at 1800 to 2200°C. The effects of excess oxygen were studied. The main feature of the reaction was the formation of a low melting uranium-molybdenum-oxygen compound. This compound attacked and penetrated grain boundaries of molybdenum cladding. In a reducing environment and at high temperatures, this compound was unstable and decomposed by losing oxygen, to yield urania and molybdenum. (F.J.H.)

340 ELECTRON- AND PROTON-TRANSFER BY THE GROTTHUSS MECHANISM IN AQUEOUS SOLUTION AND IN BIOLOGICAL SYSTEMS. Horne, R. A.; Courant, R. A.; Johnson, D. S. (Arthur D. Little Inc., Cambridge, Mass.). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-64/19, 25p. (CONF-650549-13). ORINS.

From IAEA Symposium on Exchange Reactions, Upton, N. Y.

The Fe(II)-Fe(III) electron-exchange reaction and certain long-range biological redox reactions involve the transfer of electrons by a Grotthuss-type mechanism over water bridges. The Grotthuss mechanism is also responsible for the anomalously great electrical conductivity of acidic aqueous solutions. At ordinary pressures the rate-determining step of the Grotthuss mechanism is the rotation of H_2O, or possibly H_3O^+, and not the actual proton flip itself. The Grotthuss mechanism is confined to "free" rotatable monomeric water between Frankwen clusters in liquid water and avoids areas of relative order. The concentration dependence of protonic conduction can be represented by an equation based on a cube root of concentration extrapolation and containing Arrhenius terms in which the activation energies are those for the rotation of and the formation of "holes" in the solvent water. Thus chemical energy and/or electrical energy can be transmitted rapidly over relatively great distances by the Grotthuss mechanism. Such processes are involved in a variety of phenomena of biological significance, examples being muscular contraction and the chemistry of the respiratory pigments. (auth)

341 HIGHLY IONIZED ATOMIC SPECTRA. Tilford, S. G. (Naval Research Lab., Washington, D. C.). 54p. (CONF-641022-2). Gmelin, AED-CONF-64-227-2.

From Optical Society of America, Annual Meeting, New York.

Rocket and satellite investigations are being made of highly ionized atomic spectra. The solar spectrum was photographed from beyond the wavelength cutoff in air at ~3000Å down to ~30Å, with the exception of a short region from ~150 to 75Å. The solar spectrum was also observed photoelectrically. Spectra of magnetically compressed toroidal gas discharges were studied and compared with solar spectrum. Examples of highly ionized spectra observed first in the solar spectrum are described. (59 references) (M.C.G.)

342 FEED SAMPLING TANK (Engineering Materials). (Rocky Flats Plant, Dow Chemical Co., Denver, Colo.). (CAPE–1204).

4 drawings.

This design of an agitated tank may be used for any chemical make-up application where stirring of the contents is desired. Ten impellers are used on a 1-in. stainless steel, ground-and-polished, 76-in. long shaft. The tank is fabricated from a section of a 5-in. stainless steel pipe 6 ft and 8 in. long. The vent tube, dip tube, and fill tube are 0.5 in. OD, and are fabricated of stainless steel pipe. Design details are included for the drive, drive support, impellers, nozzles, and bearings. (For details, see TID-4100). (M.C.G.)

343 CATALYST COMPOSITION CONSISTING OF A PLURALITY OF OXIDES SUPPORTED ON A ZIRCONIA AND/OR HAFNIA BASE AND PROCESS OF PREPARING SAME. Jaffe, Joseph (to Monsanto Co.). U. S. Patent 3,202,618. Aug. 24, 1965. Filed June 5, 1961.

Catalysts are described that are applicable to use in the exhaust systems of internal combustion engines to aid in preventing or minimizing the discharge of CO and noncombusted or partially combusted products to the atmosphere. The catalysts comprise a catalytically active mixture of metal oxides in the following proportions: $(CuO)_a \cdot (MO)_{1-a} \cdot Cr_2O_3 \cdot xM'O_2$ where M is a divalent transition metal other than Cu, and M′ is either Hf or Zr or mixtures of the two, a is a fractional number of from about 0.1 to 0.9, and x is a number of from about 1 to 8. The catalyst is prepared by intimately mixing the finely divided metallic oxides and calcining the mixture to a temperature in the range of 600 to 1200°C until the catalytically active inorganic oxide complex is formed. (B.L.M.)

Organic Chemistry

344 (EUR–1845,f) RECHERCHES SUR LA PREPARATION DE PROTEINES ET DE PEPTIDES MARQUES. (Studies on the Preparation of Labelled Proteins and Peptides). Leonis, J. (Brussels Univ. (Belgium)). 1965. 23p. Dep. mn.

Several proteins of egg white (lysozyme, ovalbumin, conalbumin, ovomucoid) could be labeled biosynthetically, by incorporating tritiated aminoacids (tyrosine, tryptophan, arginine, or lysine). Specific activities range from 1 to 100 mC/mM, depending on the protein and on the precursor. Starting from lysozyme tritiated by exchange, four labeled aromatic peptides were prepared whose specific activities seem to be greater than 10 mC/mM. The biosynthetic incorporation of tritiated amino acids (arginine or lysine) occurs at a different rate in the proteins of the egg white and those of the yolk, and—for the latter—still differently in the hydrosoluble and insoluble ones. Isolation of pure labeled yolk proteins has not yet been achieved. (auth)

345 (EUR–2450,d) DARSTELLUNG VON 6-AZACHOLESTERIN MIT ^{14}C AN C-4 ODER C-26. (Production of 6-Azacholesterin Labelled with ^{14}C in the C-4 or C-26

Position). Lettre, H. (Heidelberg Univ. (West Germany)). 1965. 10p. Dep. mn.

The method for the production of 6-azacholesterin from cholesterin was revised. A new route was found for the preparation of the intermediate product 3β-acetoxy-5,6-seco-cholestane-5-one acid II. With the use of cholesterin labelled with ^{14}C in the C-4 position, the required labelled 6-azacholesterin could only be obtained with difficulty. No trouble was encountered in the production of 6-azacholesterin labelled with ^{14}C in the C-26 position. Other substances produced were tritiated 6-azacholesterin, 5,6-seco-cholestane-3β,5α,6-triol and 5,6-seco-sitostane-3β, 5α,6-triol. Some of the compounds were tested in order to ascertain their effect on animal and plant cells and their distribution in the animal organism. Some radiochemical problems not previously encountered have still to be clarified. (auth)

346 (GAT-L-420) DEGRADATION OF C-816 AND C-437 WITH FLUORINE. Massoth, F. E.; Kornet, F. A. (Goodyear Atomic Corp., Piketon, Ohio). Oct. 24, 1957. Contract AT(33-2)-1. 6p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The process developed for the fluorine degradation of Freon 114, was applied to C-816 (perfluorodimethylcyclohexane) and C-437 (trichloroheptafluorobutane). Complete degradation of C-437 was achieved, and optimum reaction conditions were determined at 510-550°C. On the other hand, C-816 was found to be completely stable. (D.L.C.)

347 (TID-22251) THE ISOTOPE EFFECT IN THE STUDY OF CHEMICAL REACTIONS. Final Report, January 16, 1964–May 31, 1965. Hodnett, Ernest M. (Oklahoma State Univ., Stillwater. Research Foundation). Contract AT(11-1)-1049. 47p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Electrophilic substitution of aromatic compounds by tritium. Hydrogen atoms of benzene and alkylbenzenes were exchanged for tritium atoms in a solvent of tritiated water, trifluoroacetic acid, and sulfuric acid. The rates of exchange of hydrogen for tritium at the ortho, meta, and para positions of toluene relative to benzene was determined. Duplicate runs were made with toluene, ethylbenzene, isopropylbenzene, and tert-butylbenzene. The partial rate factors for the ortho and para positions are high (300-600), but are in the range of partial rate factors which have been found for other reactions of toluene. Significant amounts of exchange occurred with the hydrogen atoms on the side chains of isopropylbenzene and tert-butylbenzene. Free-radical Chlorination of 2-Methylpropane-2-t_1. Work has involved the quantitative study of the photochemical chlorination in the liquid phase of pure isobutane, isobutyl chloride, and tert-butyl chloride and of mixtures of isobutane and isobutyl chloride. Equilibrium between Benzophenone-carbonyl-^{14}C and Benzhydrol. The equilibrium isotope effect at 81° in this reaction was found to be 0.981 ± 0.022, compared to the calculated value of 0.997. Equilibrium isotope effects are known to be smaller than kinetic isotope effects, and this one appears not to be an exception. Decomposition of p-Nitrophenethyltrimethylammonium Iodide. The isotope effect in the decomposition of p-nitrophenethyl-1-^{14}C-trimethylammonium iodide was found to be 0.928; the theoretical isotope effect has been calculated to be 0.927. The decomposition is concerted since the slow step involves the breaking of a carbon-hydrogen bond as well as the carbon-nitrogen bond; however, the carbon nitrogen bond must be highly stretched in the transition state. Several steps in the synthesis of p-nitrophenethyl-1-^{14}C-trimethylammonium iodide could involve rearrangement of the carbon atoms of the side chain by means of a non-classical carbonium ion. Consequently, each intermediate was examined to determine the extent of the rearrangement; no significant rearrangement was found. (D.L.C.)

348 ISOTOPES AND ORGANIC REACTION MECHANISMS. Collins, Clair J. (Oak Ridge National Lab., Tenn.). Advan. Phys. Org. Chem., 2: 1-91(1964).

The use of isotopes to investigate the mechanism of reaction of organic compounds is reviewed. Illustrative examples are given of isotopic applications to: product identification and stoichiometry, identification of intermediates by physical methods, kinetic studies, stereochemical studies, and isotopic studies. The application of the radioactivity dilution technique to the determination of yield or radioactivity of a product is discussed. A special application of the isotope-dilution method is in determination of the optical purity of resolved or partially racemic optical enantiomers. Determination of radioactivity distributions and migratory aptitudes in simple tracer studies is considered with reference to studies on fused ring hydrocarbons, benzilic acid rearrangement, acid-catalyzed 1,2-shifts, and the Friedel-Crafts reaction. Experiments with two or more labels are reviewed. Three general methods are described for observing isotope effects: the kinetic method; the method of competing reactions; and the method of product analysis. Combinations of kinetic and product analysis techniques are also possible. (175 references). (BBB)

349 DEUTERIUM–HYDROGEN EXCHANGE OF MUSCLE PROTEINS. Hartshorne, D. J. (Univ. of Birmingham, Eng.); Stracher, A. Biochemistry, 4: 1917-23(Oct. 1965).

At apparent pH values of 6.3 the percentage of hard-to-exchange peptide hydrogens for the proteins light meromyosin fraction I, tropomyosin, actin, myosin, and heavy meromyosin bore little apparent relationship to their reported helical contents. Heavy meromyosin contained the highest percentage of hard-to-exchange peptide hydrogens. Increasing pH increased the exchange rate for all of these proteins. The effect of pH on the exchange rates of the highly helical proteins, light meromyosin fraction I, and tropomyosin was more marked than for the proteins heavy meromyosin and myosin. From the dissimilarity of the pH dependence of exchange of heavy meromyosin it is proposed that some conformation other than the α helix is partly responsible for the higher percentage of unexchanged peptide hydrogens in this protein. Sodium dodecyl sulfate increased the exchange rates for all the proteins but also altered considerably the physical properties of the studied proteins, heavy meromyosin and light meromyosin fraction I. (auth)

350 EQUILIBRIUM AND KINETIC STUDIES OF THE DEPROTONATION OF THE MONOANION OF SEVERAL DICARBOXYLIC ACIDS IN WATER AND IN DEUTERIUM OXIDE. Haslam, John L.; Eyring, Edward M.; Epstein, William W.; Jensen, Ronald P.; Jaget, Charles W. (University of Utah, Salt Lake City). J. Amer. Chem. Soc., 87: 4247-55(Oct. 5, 1965).

The rate constant for the rapid abstraction by a hydroxide ion of a proton from the monoanion of three alkyl-substituted succinic acids varied inversely as the ratio of the acid dissociation constants K_{a1}/K_{a2}. These data confirmed the generality of this result found previously for a series of 2,2-disubstituted malonic acids and for three cis-3,3-disubstituted cyclopropane-1,2-dicarboxylic acids. Acid dissociation constants and rate constants for the proton abstraction were determined in D_2O for the three cyclopropane acids as well as for the three succinic acids. These isotopic data as well as acid dissociation constants for the monomethyl esters of these acids are consistent with the interpretation that the breaking of an intramolecular hydrogen bond in the monoanion is rate determining although these data cannot conclusively establish the presence of such an intramolecular hydrogen bond. (auth)

351 THE HIGH IONIZATION POTENTIAL OF METHANE. Sjoegren, H. (Royal Inst. of Tech., Stockholm). Phys. Lett., 19: 210-11(Oct. 15, 1965).

The ionization potential of the (sa_1) electron was previously determined to be 19.4 ev on the basis of a break observed in the ionization efficiency curve of methane by the use of a mass spectrometer. Experimental results are summarized indicating that ionization and preionization are not the mechanisms responsible for the break and supporting the hypothesis that CH_4^+ is formed above 19.4 ev by charge exchange between CH_4 and CH_2^+. (D.C.W.)

352 SECONDARY ISOTOPE EFFECTS IN THE SOLVOLYSIS OF exo-NORBORNYL BROMIDE. Schaefer, John P.; Weinberg, David S. (Univ. of Arizona, Tucson). Tetrahedron Letters, No. 29, 2491-6(July 1965).

When the solvolysis rates of exo-norbornyl bromide and deuterium-labeled exo-norbornyl bromide were measured polarimetrically, a secondary isotope effect (k_H/k_D) of 1.087 was found. This value was about 40% less than the value predicted (1.14) by a model and provided further evidence that the transition state for the solvolysis of exo-norbornyl derivatives was stabilized by delocalization of the C_1-C_6 sigma bond. A study was made of the solvolysis of exo-norbornyl bromide-7,7-d_2 to determine the geometry of the transition state. These data provided strong evidence that the formation of the transition state in the solvolysis of exo-norbornyl derivatives is anchimerically assisted but that the geometry of the carbon skeleton is approximately that of the starting material. (BBB)

353 RELATIVE ORIENTATION OF THE TWINNED POLYTHIOMETHYLENE CRYSTALS FROM TRITHIANE BY γ-IRRADIATION. Mammi, M.; Carazzolo, G.; Valle, G. Z. Polymer Sci. Pt. B, 3: 863-70(Oct. 1965).

It is shown that the hexagonal polythiomethylene (PTM) obtained from trithiane by gamma irradiation consists of two twinned lattices, both with the a_{hex} axis parallel to the c axis of the starting trithiane crystal; their c_{hex} axes are parallel to the (hhO) and (hh$\bar{2}$O) axes of trithiane and are twisted from one another by 84°48′, by rotation about the a_{hex} axis. The actual symmetry operation relating the polymer twins may be either a 180° rotation about trithiane a (or b) axis, or a reflection across trithiane (100)[or (010)] plane. It seemed therefore justified, though not rigorous, to consider the two polymer crystals as true twinned crystals. (P.C.H.)

354 DEUTERIUM EXCHANGE STUDIES OF A MODEL AMIDE COMPOUND [Thesis]. Frank, Bruce Hill. Evanston, Ill., Northwestern Univ., 1964. 141p.

Since a model peptide system, N-methylacetamide is available, the rates of N—H → N—D exchange were examined under conditions of known content of N—H ..... O=C bonded groups. The kinetics in dioxane-water and in pure water solutions were followed by changes in absorbance in the near infrared region of the spectrum. Hydrogen and hydroxide ions were both found to catalyze the exchange reaction in the mixed solvent system. Even more striking in this mixed solvent system were the pronounced effects of imidazole and tris(hydroxymethyl)aminomethane on the velocity of the exchange reaction, increases of almost fifty-fold being observed with 0.1M concentrations. Corresponding effects were also found with other nitrogenous bases and with carboxylic acids, concentrations from 0.005 to 0.1M being effective. These studies in dioxane-water solutions using acidic and basic groups analogous to those found as side-chains of proteins, were carried out over a range of pH's and demonstrate a generalized acid-base catalysis of E—D exchange in amides. In addition, a study of the effect of hydrogen-bonding on the deuterium exchange rates was performed in the dioxane-water solvent system. The observed rates were found to be independent of the degree of association, leading to the conclusion that there is no difference in the rates of exchange of hydrogen-bonded and free N—H groups in this model system. The exchange reaction was studied in water also. Catalysis of the exchange by hydrogen and hydroxide ions as reported by others was verified. More important, however, was the demonstration of catalysis of the exchange reaction by acetic acid, methoxyamine and hydroxylamine. A study of the temperature dependence of the exchange reaction rates in the water solvent, led to the determination of the activation energies of the hydrogen- and hydroxide-catalyzed exchange rates. Values of 17 and 23 kcal/mole were found for the acid and base activation energies, respectively. It seems clear, therefore, that at least in this model of a peptide group, N-methylacetamide, a substantial activation energy is essential for exchange with deuterium even when the N—H is not hydrogen-bonded to a C=O. (Dissertation Abstr.)

Radiation Chemistry

See *also* BIOLOGY AND MEDICINE — Radiation Effects on Biochemicals Radiation Effects on Tissues

Refer also to abstracts 46 and 248.

355 (NYO-2978-42) EVALUATION OF BETA IRRADIATION OF PRESSURIZED REACTIONS. Interim Technical Status Report, November 1, 1963–October 31, 1964. Yavorsky, P. M.; Mazzocco, N. J.; Gorin, E. (Consolidation Coal Co., Library, Pa. Research Div.). Apr. 15, 1965. Contract AT(30-1)-2978. 58p. Dep. mn; CFSTI $3.00 cy, $0.50 mn.

A new type, 400-Curie ^{90}Sr, ^{90}Y beta irradiator was fabricated to supply high-intensity radiation inside a high-pressure, high-temperature chemical reactor. The source was made by swaging thin-walled stainless steel tubing over strontium-90 titanate, forming a strong, wall-supporting compaction inside. Dosimetry shows 1.69×10^6 rad/hr is supplied for radiation processing of reactions. Utilizable radiation is 22.8% of all the radiation from the 400 Curies. Source integrity was proven by no leakage over 100 operations at high pressures and temperatures. One inch of lead is adequate for shielding the external bremsstrahlung radiation. The effect of beta irradiation on the following reactions was studied at elevated temperatures and pressures: cracking of t-butylbenzene, of decalin and n-decane in the presence of hydrogen, and of the latter in the presence of isobutane; alkylation of propylene and of ethylene with isobutane; polymerization of ethylene; and telomerization of methanol with ethylene. G-values for these radiation reactions at various conditions are reported. The methanol telomerization yields high molecular weight alcohols of interest as intermediates for biodegradable detergents, with G-values ranging from 9500 at 390°C to 4000 at 265°C. Thus, this radiation reaction was selected for more thorough development. (auth)

356 (SGAE-CH-19/1965) DIE UNTERSCHIEDLICHE ZERSETZUNG VON ANTHRAZENOEL DURCH GAMMA-STRAHLUNG UND SCHNELLE NEUTRONEN. (Differences in Anthracene Oil Radiolysis by Gamma Radiation and by Fast Neutrons). Proksch, E.; Wiesinger, F. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H.; Seibersdorf. Institut fuer Chemie). [1965]. 28p. Dep. mn.

Measurements in a reflector position of the ASTRA were used in combination with earlier measurements in the center of the ASTRA core to extrapolate the radiolytic decomposition of VÖEST Anthracene Oil I by pure γ radiation and fast neutrons, respectively. The G^0_γ values are independent of temperature: G^0_γ (→ HBR) = 0.22 ± 0.04, G^0_γ (gas) = 0.016 ± 0.010. G^0_n (→ HBR)/G^0_γ (→ HBR) increases from 2.6 ± 0.5 at 200 to 275°C to 5.1 ± 1.0 at 380°C, G^0_n (gas)/G^0_γ (gas) increases from 7 ± 4 at 200°C to 20 ± 12 at 380°C. Parallel measurements using a terphenyl mixture for comparison yielded a G^0_γ (→ HBR) of about 0.15 and a G^0_n (→ HBR) of about 0.30, both independent from temperature in the range of 275 to 350°C. Radiolytic tar (HBR, high boiling residues) from Anthracene Oil I was found to decompose back to anthracene oil when pyrolyzed at temperatures higher than the temperature during radiolysis. (auth)

357 (USNRDL-TR-896) THE RADIOLYTIC DECOMPOSITION OF 1,1-DIMETHYLHYDRAZINE, DIETHYLENETRIAMINE AND HYDYNE ROCKET FUELS. Shelberg, W. E. (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 19, 1965. 22p.

One hundred-milliliter samples of the storable liquid rocket fuels, 1,1-dimethylhydrazine, diethylenetriamine, and Hydyne generate respectively 199.0, 101.2, and 164.1 ml of radiolytic off-gas (measured at 25°C and 1 atm) when irradiated to 8.5×10^6 rads with gamma rays. The result for Hydyne was calculated from those for 1,1-dimethylhydrazine and diethylenetriamine, Hydyne consisting of 60

wt % of the former and 40 wt % of the latter. When the samples contain 5 vol % of the free-radical scavenger methyl methacrylate, the off-gas volumes are reduced respectively by 18.2, 11.0, and 16.7 %. Since the free-radical scavenger reduces somewhat the off-gas from the fuels due to laboratory ionizing radiation, it may be expected to improve their storability somewhat with respect to ionizing space and nuclear rocket radiations. (auth)

358 (NP-tr-1299) CONDENSATION OF CELLULOSE CROSS-LINKING AGENTS BY ELECTRON IRRADIATION. Ruettiger, W.; Heinze, D. Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.), from Paper T.8 presented at the Symposium on the Use of Radioactive Isotopes in Textile Research and Industry, Lindau/Bodensee, 8–10 July 1964. Original text published in Anwendung Radioaktiver Isotope in der Textilforschung und -Technik, Thiemig-Taschenbuch No. 9, by Karl Thiemig KG, Munich 9, Germany. 29p. Dep. mn; JCL $2.60 fs, $1.07 mf.

An attempt was made to crosslink regenerated cellulose fabrics with N-methylol compounds by means of electron irradiation, for the production of non-iron fabrics. Dimethylol ethylene urea was used as the crosslinking agent, and electron doses of 10^6 to 10^7 rads were used. Crease angles, leaching-out losses, and tearing strength of the resulting fabrics were determined. The results indicate that no radioinduced crosslinking by condensation with N-methylol compounds occurs in regenerated cellulose, and that thermal or catalytic conversion results in partial radiation protection. (D.L.C.)

359 THE REACTIONS OF ENERGETIC TRITIUM AND CARBON ATOMS WITH ORGANIC COMPOUNDS. Wolf, Alfred P. (Brookhaven National Lab., Upton, N. Y.). Advan. Phys. Org. Chem., 2: 201-77(1964).

The chemical effects of nuclear transformations are reviewed, with emphasis on the hot-atom chemistry of tritium and carbon. A general discussion of the hot-atom process includes a consideration of recoil energy, bond rupture after a nuclear event, slowing down of the hot atom, and theoretical approaches to reaction models. In investigating the reactions of a recoil species it is of interest to separate reactions brought about by the hot-atom from those that involve the recoil species after it has thermalized. The criteria for separation of the two areas as applicable to any particular reactive system are product-dependence on temperature, phase, scavenger, and moderator. If a product yield is not dependent on temperature, is the same in all phases, is dependent on scavenger in a chemically predictable way, and is sensitive to moderator concentrations in the applicable range, then it is a hot product. A discussion of the chemical effects includes annealing, radiation effects, impurities, and isolation and assay of products. Various reactions of hot H and C atoms are outlined. Work with tritium in condensed phases supports the concept of the excited intermediate. Studies indicated that the initial encounter between a carbon atom and the substrate, which ultimately leads to a recognizable product, involves a reaction formally analogous to an insertion reaction. The insertion may involve carbon in its electronic ground state or one of its low-lying excited states. The formation of a complex, which can ultimately result in a product that can be isolated, can be described in terms of a reaction cross section. The nature of the product from the insertion complex depends on the structure of the complex and the modes of decay available to it. Three molecular species: $[:\dot{C}H]^*$, $[:CH_2]^*$ and $[CH_3]^*$, which can be considered as primary reactants, can result from successive insertion reactions (or possibly abstraction reactions) provided sufficient energy is available in the first encounter. All three species, as first formed, can be considered to have excess vibrational and translational energy and may not be in their electronic ground state. Results in condensed phases and with polyfunctional compounds also support the postulate of excited intermediates. Product distribution is then a function of the specific chemistry of the system. (175 references). (BBB)

360 THE EVIDENCE FOR THE FORMATION OF CHLORINE ATOMS IN NEUTRAL AQUEOUS SOLUTION CONTAINING CHLORIDE IONS BY IONIZING RADIATIONS. Matsuyama, Akira; Namiki, Mitsuo (Inst. of Physical and Chemical Research, Tokyo). Agr. Biol. Chem. (Tokyo), 29: 593-4(June 1965).

In acid solution, halide ions (X^-) presumably react with radioinduced OH radicals resulting in the production of halogen atoms (X); $G(H_2O_2)$ decreases with increasing X^- concentration. The mechanism may involve competition between the following two reactions: $OH^- + OH^- \rightarrow H_2O_2$ and $OH^- + H^+ + X^- \rightarrow H_2O + X$. In neutral solutions, Br^- and I^- also react with OH^-. On the other hand, decreases in $G(H_2O_2)$ by Cl^- is pH dependent, and Cl^- does not react with OH^- in neutral solutions but it does react in acid solutions. The possibility of formation of chlorine atoms in neutral aqueous systems containing Cl^- at higher concentrations was investigated. Results indicated that spur reactions to form Cl atoms in neutral solutions occurred. These results showed that: $G(H_2O_2)$ was only decreased at Cl^- concentrations greater than 0.14M and the decrease was linear with the cube root of the Cl^- concentration; the critical Cl^- concentration (0.14M) at which the decrease in $G(H_2O_2)$ became observable was identical with air- or oxygen-saturated and deaerated solutions; no dose effect was seen at this concentration of Cl^-, OH^- prevented the decrease of $G(H_2O_2)$ by Cl^-; and $G(H_2O_2)$ became less than G_F, where G_F is the H_2O_2 yield for the forward reaction and ~0.4 for ^{60}Co γ rays, with increasing Cl^- concentrations. Observations were obtained, which supported the view that Cl atoms may be produced as a radioinduced intermediate in a series of spur reactions in neutral solution. (BBB)

361 THE RADIOLYSIS OF ETHYLENE GLYCOL DIACETATE. Isoya, Toshiro; Hirota, Kozo; Hatada, Motoyoshi (Japanese Association for Radiation Research on Polymers, Osaka). Bull. Chem. Soc. Jap., 38: 1722-6(Oct. 1965).

The radiolysis of air-free ethylene glycol diacetate by ^{60}Co γ rays was studied at room temperature. Irradiation gave five gaseous and six liquid products. The G value of the total of all the gaseous products was 2.18 and of the EGDA decomposition was 2.5. The effect of DPPH addition on the radiolytic products, the relation between radiolytic products and the mass spectrum of unirradiated EGDA, and the ESR spectrum of irradiated EGDA were also studied. No remarkable difference in the products was found between EGDA and various monoacetates except in the gaseous products, the yields from EGDA being $\frac{1}{2}-\frac{1}{3}$ of those from methyl acetate. (auth)

362 RADIATION-INDUCED CATALYTIC ACTIVITY OF NICKEL OXIDE. Yamashina, Toshiro; Sano, Masakatus (Hokkaido Univ., Sapporo). Bull. Chem. Soc. Jap., 38: 1801(Oct. 1965).

The radioinduced catalytic activity of nickel oxide was determined by using the decomposition of a 7.5% hydrogen peroxide solution as a model reaction, in which the rate of the reaction was followed by reading the volume of oxygen evolved per minute. The values for catalytic activity and chemisorbed oxygen were both found to increase with radiation dose, being remarkable over a total dose of about 1×10^8 and reaching a level over twice as great as non-irradiated nickel oxide. It is suggested that catalytic action takes place preferentially at the oxygen chemisorbed with irradiation. (P.C.H.)

363 PROPERTIES OF GRAFT COPOLYMERIZED CELLULOSE FIBER. II. BUTADIENE GRAFTED COTTON AND RAYON. Tsuji, Waichiro; Imai, Masazo (Kyoto Univ.). Bull. Inst. Chem. Res. Kyoto Univ., 43: 94-101 (Jan. 1965).

Butadiene, butadiene-styrent, or butadiene-acrylonitrile were graft copolymerized onto cotton or rayon using high energy radiation and some properties of the grafted fibers were studied. It was found that elasticity, heat-settability, abrasion-resistance, and adhesion to rubber were markedly

improved and the coefficient of friction of fabric was decreased by the grafting. (NSA of Japan)

364 RADIATION-INDUCED CHANGES IN THE UNSATURATION OF POLYISOPRENE. Golub, Morton A.; Danon, Jeanne (Stanford Research Inst., Menlo Park, Calif.). Can. J. Chem., 43: 2772-85(Oct. 1965).

Polyisoprene in the solid state and in benzene solution undergoes radioinduced cis-trans isomerization and loss of unsaturation. Starting with various cis or trans polymers, the isomerization approaches an equilibrium in which the cis/trans ratio is around 50/50 for polyisoprenes irradiated in solution or in the solid state. The G(isom) values for either cis → trans or trans → cis isomerization, i.e., the number of cis (or trans) units isomerized initially per 100 ev absorbed by both polymer and solvent, in 1% solution, and by polymer alone, in the solid state, are about 1.0 and 10, respectively. The energy transfer mechanism proposed previously for polybutadiene and squalene isomerization is assumed to hold for polyisoprene as well. The loss of unsaturation in films irradiated with electrons under nitrogen is twice as rapid as in films γ irradiated in vacuo, the G(-d.b.) d.b. = double bond) values being 13.4 and 6.7, respectively. Correspondingly, G(-d.b.) for a γ-irradiated solution is 27, calculated in terms of energy absorbed directly by the polymer; intermolecular energy transfer is again indicated, although phenylation may also contribute to the loss of double bonds in solution. The large drop in unsaturation in solution and in the solid state is attributed to a chain process involving cyclization and some cross-linking, with the participation of both free radicals and carbonium ions. Work with polyisoprene-3-d confirmed the importance of isomerization and loss of unsaturation and gave an activation energy of 1.1 kcal/mole for the latter reaction. (auth)

365 DEGRADATION SPECTRUM OF ELECTRONS, ELECTRONIC EXCITATION SPECTRA OF MOLECULES, AND PRIMARY RADIATION CHEMICAL YIELD. Prasil, Z.; Vacek, K.; Bednar, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collect. Czech. Chem. Commun., 30: 2693-2702(Aug. 1965).

Based on the optical approximation, relations were derived for the primary radiation chemical yield of pure substances and their mixtures. The limited validity of this approximation and consequences for radiolysis of mixtures are discussed. (auth)

366 STUDY OF A POLYMER MIXTURE BY RADIOTHERMOLUMINESCENCE. Buben, N. Ya.; Gol'danskii, V. I.; Zlatkevich, L. Yu.; Nikol'skii, V. G.; Raevskii, V. G. (Inst. of Chemical Physics, Academy of Sciences, SSSR; Moscow Technological Inst. of Meat and Dairy Industry). Dokl. Akad. Nauk SSR, 162: 370-2(May 11, 1965). (In Rusian).

Radiothermoluminescence was used to evaluate the extent of homogeneity of polymer mixtures. Butadiene elastomers, identical in composition but differing with regard to content of vicinal bonds, were mixed on rollers in various proportions. After degassing, the mixture samples were irradiated with fast electrons at 77°K (dose: 1 rad) and allowed to warm up at the rate of 10 to 12°C per min. Previous work showed that each of the two elastomers had a well-resolved luminescence maximum corresponding to the vitrification temperature of the elastomer. It was found that when the two elastomers are mixed insufficiently the mixture exhibits two luminescence maxima. On the other hand, when the mixture was sufficiently homogeneous, only one maximum was observed, somewhere between the two maxima of the individual elastomers. (CFSTI)

367 RADIATION-INDUCED BLOCK OR GRAFT COPOLYMERS OF METHYL METHACRYLATE WITH ISOBUTYLENE AND ETHYLENE-PROPYLENE RUBBERS. Pellon, Joseph; Valan, Kent J. (American Cyanamid Co., Stamford, Conn.). J. Appl. Polymer Sci., 9: 2955-64(Sept. 1965).

Attempts to prepare block or graft copolymers of isobutylene rubbers by radiation in the presence of methyl methacrylate gave low yields of copolymer with only 20% of the rubber entering into the copolymer. The remainder of the rubber was degraded during the process. A single experiment describes the graft copolymerization of methyl methacrylate with ethylene–propylene rubber in which 45% of the rubber is copolymerized. (auth)

368 IRRADIATION OF ALUMINA CATALYSTS. Acres, G. J. K.; Eley, D. D.; Trillo, J. M. (Univ. of Nottingham, Eng.). J. Catalysis, 4: 12-21(Feb. 1965).

Kinetics of both para-ortho hydrogen conversion and hydrogen-deuterium equilibration on α alumina before and after γ irradiation are reported. The first reaction, studied at 77°K, led to information about the presence of unpaired electrons acting as paramagnetic surface sites. Thermal activation of α alumina in vacuo created active centers in the surface, which catalyzed the para-hydrogen conversion (examined over 77° to 823°K) and the H_2D_2 equilibration (193° to 823°K). The conversion mechanism was mainly paramagnetic at low temperatures, changing to mainly chemical at high temperatures, while the equilibration can only involve the chemical mechanism. The apparent activation energy of the conversion was 290 cal $mole^{-1}$ from 77 to 383°K, and above 383°K, where the rate was a maximum, it was −490 cal $mole^{-1}$. The activation energy for the H_2D_2 equilibration was 1400 cal $mole^{-1}$. The active centers were thermally stable, and showed negligible ESR signal. Irradiation of the thermally activated catalyst in vacuo at 77°K with γ rays from ^{60}Co give an ESR signal with an absorption line 40 G wide. It was stable up to 193°K but annealed out at 273°K. There was a proportional increase in activity of irradiated catalysts for the para-hydrogen conversion, but no increase in the rate of H_2D_2 equilibration. Catalysts heated to only 200°C in vacuo and therefore catalytically inactive, on γ irradiation at room temperature were brought up to the level of activity produced otherwise by thermal activation at 550°C. (BBB)

369 GAS-PHASE RADIOLYSIS AND PHOTOLYSIS OF NEOPENTANE. Lias, Sharon G.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 43: 2748-59(Oct. 15, 1965).

The photolysis of neo-C_5H_{12}-neo-C_5D_{12} mixtures was investigated at 1470 and 1236 Å. From the products formed in the absence and presence of NO or H_2S, the occurrence of the following fragmentation processes could be derived: neo-$C_5H_{12}^* \rightarrow CH_4 + iso\text{-}C_4H_8$, $CH_3 + H + iso\text{-}C_4H_8$, $CH_3 + CH_3 + C_3H_6$. These modes of decomposition also prevail when neopentane is excited by collision with electrons accelerated by an electrical field applied during radiolysis. At 1236 Å, the relative probabilities of occurrence of the processes are approximately 1.0, 4.5, and 1.1. From the isotopic analysis of the products formed in the direct and inert-gas-sensitized radiolysis of neo-C_5H_{12}-neo-C_5D_{12} mixtures in the presence of NO, O_2, or I_2 as free-radical scavengers, it could be derived that the fragment ions $C_2H_3^+$, $C_2H_5^+$, $C_3H_5^+$, and $C_3H_7^+$ are formed and undergo hydride-ion transfer reactions with neopentane to form C_2H_4, C_2H_6, C_3H_6, and C_3H_8, respectively. Assuming that this is the only mode of reaction of these ions in the system, ion-pair yields of 0.028, 0.068, 0.062, 0.015 are obtained for the above listed ions at a pressure of 30 torr. The propyl ion, which has a secondary propyl structure, undergoes a hydride transfer reaction with neopentane at a rate which is slower by more than one order of magnitude than the analogous reactions of the ethyl or allyl ions. It is observed that this relatively slow ion-molecule reaction is inhibited when an electric field is applied to the system, probably because of the collection of propyl ions on the cathode. In agreement with mass-spectrometric results, it is suggested that propyl ions are formed mainly as a result of the decomposition of the $C_5H_{11}^+$ ion which is formed in the hydride-ion transfer processes. The $C_4H_9^+$ ion does not react with neopentane but does, under certain conditions, yield isobutene by an unspecified process. The ion-pair yield of isobutene increases with increasing pressure and with diminishing recombination energy of added inert gas. In the direct radiolysis, the ion-pair yields of the fragment ions formed with appearance potentials above that of $C_4H_9^+$ are seen to diminish when the pressure is increased, while, in the inert-gas-sensitized radiolysis, most of these ions

increase with an increase of the recombination energy of the inert-gas ions, Xe^+, Kr^+, Ar^+, and Ne^+. (auth)

370 BEHAVIOR OF ION SPURS AND TRACKS IN IRRADIATED DIPOLAR SYSTEMS. Schiller, Robert (Central Research Inst. for Physics, Budapest). J. Chem. Phys., 43: 2760-4(Oct. 15, 1965).

The problem of electron moderation and subsequent recapture or escape in irradiated dipolar substances is investigated theoretically. By considering the dielectric relaxation, the electric energy of a spur or track consisting of positive ions and diffusing electrons is evaluated. The moderation being fast as compared with the dielectric relaxation time, the energy content of the spur or track decreases due to an increase in the dielectric constant after the moderation is completed. At the expense of this energy decrease, some thermalized electrons may diffuse away from the field of the positive ions if they are slow enough not to increase the spur energy faster than it is decreased by dielectric relaxation. The theory is tentatively applied to γ and α-irradiated water and ice and, while a substantial fraction of electrons is found capable of escaping in the liquid state, for the crystalline state complete recapture is predicted. (auth)

371 PARAMAGNETIC RESONANCE OF ALKYL RADICALS FROM DISSOCIATIVE ELECTRON ATTACHMENT IN γ-IRRADIATED ORGANIC GLASS. Skelly, D. W.; Hayes, R. G.; Hamill, W. H. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 43: 2795-8(Oct. 15, 1965).

The radicals $CH_3\cdot$, $CH_3CH_2\cdot$, $CH_3CH_2CH_2\cdot$, $(CH_3)_3C\cdot$, $(CH_3)_3CCH_2\cdot$, and $C_6H_5\dot{C}HCH_3$ were identified by EPR in γ-irradiated dilute solutions of the corresponding halides in 3-methylpentane at 77°K. For 0.4 mole % CH_3I, $G(CH_3\cdot) = 1.2$. Methyl radicals disappear by some first-order rate process for which $k = 4.6 \times 10^{-4}$ sec^{-1}. Other radicals did not decay measurably under similar conditions. The results are consistent with the mechanism of dissociative thermal electron attachment, $RX + e^- \rightarrow R\cdot + X^-$, which is an efficient, selective process whenever the electron affinity of X exceeds the bond dissociation energy of R – X. (auth)

372 ELECTRON SPIN RESONANCE OF γ-IRRADIATED FLUOROALCOHOLS. Lontz, Robert J. (Army Research Office, Durham, N. C.). J. Chem. Phys., 43: 2914-15(Oct. 15, 1965).

A search was made of a number of fluorocarbon acids, amides, and alcohols, to determine if the characteristic polytetrafluorethylene radical could be observed in a low-molecular-weight compound with the repeating $-CF_2-$ group. The observation of such a free radical in gamma-irradiated C_{11} fluoroalcohol $H(CF_2CF_2)_5CH_2OH$ was reported. No free radicals were detected in the solid material following irradiation at room temperature for a 24-hr period with a kilocurie ^{60}Co source. But irradiation and observation of the sample at 77°K produced a free-radical spectrum, which is shown. Similar absorption spectra are obtained by irradiation and observation at 77°K of the fluoroalcohols, $H(CF_2CF_2)_nCH_2OH$ where n = 2, 3, and 4. The tracings also show the appearance of the peroxide radical. (J.F.P.)

373 PROTON-DEUTERON EXCHANGE OF THE RADICAL IN IRRADIATED SINGLE CRYSTALS OF DL-ASPARTIC ACID: EFFECT OF THE CRYSTAL FIELD ON THE CHEMICAL REACTION. Miyagawa, Ichiro (Duke Univ., Durham, N. C.); Itoh, Koichi. J. Chem. Phys., 43: 2915-16(Oct. 15, 1965).

The proton-deuteron exchange reaction of the radical in irradiated single crystals of alanine, studied by the electron spin resonance method, is extended to deuterium-substituted DL-aspartic acid, $DOOCCH_2CH(ND_2)\cdot COOD$, and the reaction is investigated in the range from room temperature to 150°C. The observed exchange was essentially similar to that in alanine. The protons of the radical $DOOCCH_2CHCOOD$, exchanged with deuterons of the host crystal; the reaction rate increased with increasing temperature when the irradiated crystal was heated to 150°C for 3 hr, practically all the radicals in the crystal were converted to $DOOCCD_2CDCOOD$. The exchange rates were measured for the three hydrogens and the ratios of these exchange rates were also found. It was concluded that the large difference between the exchange rates for the two hydrogens originates from the crystal field. (J.F.P.)

374 ESR STUDY OF X-IRRADIATED SODIUM THIOSULFATE SINGLE CRYSTALS. deLisle, Janice M.; Golding, R. M. (D.S.I.R., Lower Hutt, N. Z.). J. Chem. Phys., 43: 3298-3303(Nov. 1, 1965).

Three paramagnetic species were observed in x irradiated single crystals of sodium thiosulfate. Two of the radicals were identified as SO_3^- and SO_2^+ with principal g values of 2.0070, 2.0047, 2.0095 and 2.0070, 2.0105, 2.0305, respectively. The orientation of the SO_2^+ radical in the crystal lattice is discussed. (auth)

375 ELECTRON SPIN RESONANCE STUDIES OF γ- AND X-RAY-IRRADIATED ZEOLITES. Kasai, Paul H. (Union Carbide Research Inst., Tarrytown, N. Y.). J. Chem. Phys., 43: 3322-7(Nov. 1, 1965).

Electron spin resonance studies revealed the formation of superoxide ions O_2^- attached to the zeolitic cations when the Type Y zeolites (Linde's) were irradiated by γ and x rays in the presence of oxygen. A second unique color center was found when Na–Y zeolite was irradiated in vacuum. This center is attributed to an electron trapped within a large cavity shared among four Na^+ ions. (auth)

376 POST-IRRADIATION REACTIONS IN NEUTRON-IRRADIATED LIQUID BROMOBENZENE. Katsanos, N. A. (Nuclear Research Centre Democritus, Aghia Paraskevi Attikis, Greece). J. Chem. Soc.: 4751-7(Sept. 1965).

The post-irradiation reaction in liquid bromobenzene, discovered earlier, was investigated at other temperatures, and also in heptane solution. After neutron irradiation, the organic ^{82}Br activity showed a rapid increase with time, followed by a plateau in which very little or no change occurred. In most cases, the reaction followed second-order kinetics with respect to a fraction of the inorganic ^{82}Br concentration. Irreproducibility observed earlier in the kinetics was removed by employing a separation of the inorganic from the organic activity, using heptane and a saturated solution of potassium bromide in ethanol. By following the reaction very soon after the end of the irradiation, values of total organic retention of ^{82}Br in pure bromobenzene as low as 23.3% could be detected. This retention increased to 66.7% after 1 hr at 50°C. Extrapolation of the second-order plots to zero time gave values of retention close to zero. No such reaction could be detected for the ^{80m}Br activity. The values of total retention obtained were in agreement with those reported in the literature, irrespective of the time of keeping prior to analysis. In irradiated pure bromobenzene, the post-irradiation reaction at low temperatures did not appear to be temperature dependent, and the larger fraction of the increase in organic ^{82}Br was due to an increase of the parent compound activity. When solutions of bromobenzene in heptane were irradiated, the same phenomena were observed, but the final retentions obtained were lower, this being almost exclusively due to a decrease in retention of parent compound. The method of purification of the bromobenzene and the neutron flux used in irradiations did not appear to affect the course of the reactions and the values of the retention obtained. A possible mechanism of the reaction is discussed, and the removal of irreproducibility in bromobenzene experiments, widely reported in the literature, is pointed out. (auth)

377 EFFECTS OF ADDITIVES ON THE RADIOLYSIS OF CYCLOHEXANE VAPOR AT 100°. Theard, Leslie M. (Sandia Lab., Albuquerque, N. Mex.). J. Phys. Chem., 69: 3292-8(Oct. 1965).

The effects of benzene, ethylene, propylene, cyclohexene, nitric oxide, iodine, and hydrogen iodide on the γ radiolysis of cyclohexane vapor at 100° were studied in an effort to determine some details of the radioinduced energy degradation processes. Benzene, the olefins, and iodine markedly reduced the yield of hydrogen to a comparable degree, while nitric oxide reduced hydrogen considerably less, and hydrogen iodide increased hydrogen. Of the gaseous hydrocarbon products, determined in the presence of all the additives

studied except ethylene and propylene, the unsaturated products (ethylene, propylene, and acetylene), which comprise the major fraction, were practically unaffected by benzene, cyclohexene, or nitric oxide. Iodine and hydrogen iodide did not affect the yields of ethylene and acetylene, but did reduce the yield of propylene. Yields of ethane and propane were reduced by several additives but were unaffected by hydrogen iodide. The observed additive effects on the gaseous products appeared to be unattributable to ionization transfer. The olefins and benzene apparently reduced hydrogen yield by two processes which are suggested to be scavenging of hydrogen atoms and scavenging of ionic precursors of hot hydrogen atoms, where the scavengeable ions are not also precursors of gaseous hydrocarbon products. Depression of hydrogen yield by iodine is explained by a combination of electron capture and hydrogen atom scavenging. It is suggested that reduction of the yield of propylene by I_2 and HI is attributable to electron capture and that reduction of the yields of ethane and propane by several additives is effected by scavenging of ethyl and propyl radicals. (auth)

378 A STUDY OF THE RADICAL TERMINATION MECHANISMS IN THE RADIOLYSIS OF CRYSTALLINE CHOLINE CHLORIDE. Smith, Margaret A.; Lemmon, Richard M. (Univ. of California, Berkeley). J. Phys. Chem., 69: 3370-3(Oct. 1965).

A search was made for the termination mechanism in the radical-induced decomposition of irradiated crystalline choline chloride. It appears that the chain propagating radical, $CH_3\dot{C}HOH$ or $\cdot CH_2CH_2OH$, terminates by reaction with another radical [possibly $(CH_3)_3\dot{N}\cdot$] that propagates into its vicinity. Other possible radical termination mechanisms, such as dimerization to a butanediol or disproportionation to ethanol and acetaldehyde, appear to play only negligible roles. (auth)

379 RARE GAS SENSITIZED RADIOLYSIS OF METHANE. Aquilanti, Vincenzo (C.N.E.N., Univ., Rome). J. Phys. Chem., 69: 3434-40(Oct. 1965).

The results of a systematic investigation of the xenon-, krypton-, and argon-sensitized radiolysis of methane and of CH_4-CD_4 mixtures in the gas phase are reported. The results are interpreted in terms of nonionic mechanisms for xenon sensitization and of ionic processes for krypton and argon sensitization. (auth)

380 RADIOLYSIS OF LIQUID NITROGEN TETROXIDE. Castorina, Thomas C.; Allen, Augustine O. (Picatinny Arsenal, Dover, N. J.; Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 69: 3547-51(Oct. 1965). (BNL-9060).

Liquid N_2O_4 decomposes under γ rays with a very small yield to N_2, N_2O, and N_2O_5. The N_2O_5 is stabilized against thermal decomposition by the γ rays, which cause the products O_2 and N_2O_4 to re-form N_2O_5 in N_2O_4 solution. Detailed data are given on the kinetics of product formation and on the effects of added O_2 and NO on the course of the reactions. (auth)

381 EFFECTS OF TEMPERATURE IN THE RADIOLYSIS OF METHANE AND PROPANE. Bone, L. I.; Firestone, R. F. (The Ohio State Univ., Columbus). J. Phys. Chem., 69: 3652-4(Oct. 1965).

A comparative study was made of variations of $G(H_2)$ with respect to temperature at very small conversions in a hydrocarbon in which abstraction is believed to predominate at 25°C (C_3H_8) and in CH_4 in order to provide more definitive insight into the question of methane's apparent inertness to H atom attack. The results showed that $G(H_2)$ in propane is independent of temperature between −29°C and room temperature. The average value for $G(H_2)$ in the absence of added scavenger is 5.6 ± 0.5 molecules/100 ev (extreme deviation from the mean) at 0.01% conversion based on the assumption that $G(-C_3H_8) \simeq 10$ molecules/100 ev. $G(H_2)$ from CH_4 in a Pyrex vessel was the same at 32° as at 100°. Data obtained at 150°C in a steel vessel showed that the unscavengeable yield of H_2 is unchanged but that the total yield of H_2 from initially pure CH_4 is about 30% greater than at room temperature in the steel vessel or at 100°C in the Pyrex vessel. The results suggest that the abstraction step does not contribute significantly to the formation of H_2 in the radiolysis of CH_4 between 25 and 100°C but that it must be considered in the vicinity of 150°C and above. (P.C.H.)

382 THERMAL GLOW OF SOME COMMERCIAL GLASSES IRRADIATED BY THE ULTRAVIOLET, X- AND γ-RAYS. Kishii, Toru; Sakurai, Junji (Tokyo Shibaura Electric Co., Japan). Jap. J. Appl. Phys., 4: 698(Sept. 1965).

The thermally induced luminescence of irradiated silica glass, Terex glass, lead borosilicate glass, and plate glass was measured using a multiplier. (D.C.W.)

383 RADIATION-INDUCED POLYMERIZATION OF CYCLIC DIENES. Miyake, Hideo; Wada, Takeshi; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). Kobunshi, Kagaku, 22: 265-72(1965). (In Japanese).

The ^{60}Co γ-promoted polymerization of 1,3-cyclohexadiene (1,3-CHD) and 1,2-dimethylenecylohexane (1,2-DMCH) was compared with the polymerizations induced by radical and cationic catalysts. 1,2-DMCH was easily polymerized with a radical catalyst, but the polymerizability by cationic catalyst was lower than with 1,3-CHD. Polymer was obtained in a high yield at the temperature range between 30 and 50°C by γ irradiation, but almost no polymer was obtained at −78°C, even in CH_2Cl_2 solution. A radical mechanism is proposed in the first case and a cationic one in the second. The polymer obtained had the high crystalline structure expected for an all cis-1,4-addition configuration. The rate of radioinduced polymerization of 1,3-CHD at room temperature was very low. On the contrary, a high rate of polymerization was observed at the lower temperature in CH_2Cl_2. This monomer had a lower polymerizability with a radical catalyst, but was easily polymerized with a cationic catalyst. It is suggested that the reason for lower polymerizability of 1,3-CHD by a radical catalyst is hydrogen abstraction from ring $-CH_2-$ to make a degradative chain transfer reaction. The lower polymerizability of 1,2-DMCH by an ionic catalyst is explained by the termination reaction accompanying positive charge transfer and H^+ derivation. The infrared absorption bands of the products are tabulated. (BBB)

384 COMPARISON OF THE ULTRAVIOLET AND γ-RAY INDUCED PRODUCTION OF UNSATURATION AND COLOR IN POLYVINYL CHLORIDE. Golub, Morton A.; Parker, John A. (Stanford Research Inst., Menlo Park, Calif.). Makromol. Chem., 85: 6-19(1965).

A study was made of the spectroscopic changes produced in thin polyvinyl chloride (PVC) films when irradiated in vacuum at room temperature with uv and ^{60}Co γ radiation. At doses up to 2×10^{22} quanta/g PVC for uv radiation (2200 to 3400 Å), or 100 Mrad for γ rays, the kinetic plots for increased absorbance throughout the uv-visible spectrum brought about by these two radiations were fully superimposable. In terms of absorbed energy units needed to produce the same spectroscopic changes (and hence the same conjugated unsaturation or the same HCl evolution), it was thus found that γ radiation is about 13 times as efficient as uv radiation. This result, for films containing 3 to 5% residual ketonic solvent, correlated well with corresponding literature data on the photo- and radiochemical evolution of HCl from solvent-free PVC. The quantum yield for the former process is shown to be independent of wavelength below 3400 Å, which is the effective photochemical cut-off wavelength. Since PVC does not contain any chromophoric groups, which absorb in the ordinary uv range, theoretically it should be unaffected by uv irradiation, but in actual fact it undergoes considerable photolysis presumably because of the presence of trace impurities, which do absorb uv radiation, and which can transfer the energy thus acquired to the vulnerable carbon-chlorine bonds. It is believed that even in very pure PVC there is a minor but adequate residual unsaturation resulting from some loss of HCl in the course of commercial processing to make the polymer photoreactive, and where the PVC films contain a significant amount of solvent, it is a source of uv absorption. (BBB)

385 MECHANISM OF RADICAL DECAY IN IRRADIATED POLYETHYLENE. Geymer, D. O.; Wagner, C. D. (Shell Development Co., Emeryville, Calif.). Nature, 208: 72-3(Oct. 2, 1965).

Investigations of the decay of free radicals in irradiated polyethylene demonstrate that the sec-alkyl radicals, formed with a G-value of about 3, decay at a significant rate at room temperature to leave a much smaller number of allyl-type radicals that decay at a very much slower rate. Discussion is given on whether the alkyl radicals decay by first-order or second-order kinetics. Arguments are given for both sides. (P.C.H.)

386 ELECTRON SPIN RESONANCE INVESTIGATIONS OF ULTRA-VIOLET AND X-IRRADIATED HOMOCYSTEINETHIOLACTONE. Koch, R.; Moenig, H. (Univ., Freiburg i. B.). Nature, 208: 86(Oct. 2, 1965).

Polycrystalline, d,l-homocysteinethiolactone (HCT) with a bulk volume of about 220 cm^3/100 g was sealed under vacuum (10^{-3} torr) and x- and uv-irradiated at room temperature. After x irradiation a radical yield of 10.8/100 ev was obtained. Though it was not possible to differentiate the obtained spectrum of the polycrystalline material, it was possible to ascertain that there exists no sulfur radical state. There was also no detectable sulfur radical with uv irradiation. The results demonstrate that not only the primary formation of sulfur radicals but also the transfer of the radical state to the sulfur atom depends on the chemical binding of the bivalent sulfur. (P.C.H.)

387 ENERGY LOSS BY FISSION FRAGMENTS IN NITROGEN. Axtmann, Robert C.; Sears, John T. (Princeton Univ., N. J.). Nucl. Sci. Eng., 23: 299-305(Nov. 1965). (NYO-2807-14).

Energy loss by fission fragments in nitrogen gas was studied by means of a pulse technique that measured luminescence excited by a low-intensity ^{252}Cf spontaneous fission source. A kinetic analysis of competing emission and quenching reactions was developed that gives the power law dependency of energy loss by the fragments in a luminescing gas from the pressure at which maximum luminosity is observed. For nitrogen, the relation $E = E_0(1-f)^{1.70\pm0.07}$ is valid for $0.4\ E_0 < E < E_0$. The term E is used for the kinetic energy of a fission fragment of initial energy E_0 that has traveled a fraction f of its total range. (auth)

388 RADIATION-INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. IX. EFFECT OF pH ON REDOX PROCESSES IN THE IRRADIATED Fe–H_2SO_4–ISOBUTYL ALCOHOL–H_2O–O_2 SYSTEM. Broszkiewicz, Roman (Inst. for Nuclear Research, Warsaw). Nukleonika, 10: 303-10(1965).

Oxidation of ferrous and reduction of ferric ions was observed in irradiated aqueous solutions containing initially ferrous ions, isobutyl alcohol, and oxygen. The solutions were investigated either in 10^{-3}N H_2SO_4 or at pH 5.25. The effects of other organic additives were tested. The results are consistent with those obtained previously for similar solutions in 0.1N H_2SO_4 and show that such a system may be useful as a model in radiobiological research. (auth)

389 EPR SPECTRA OF GAMMA IRRADIATED SINGLE CRYSTALS OF β-SUCCINIC ACID. Minc, Stefan; Kecki, Zbigniew; Kosek, Stanislaw (Inst. of Nuclear Research, Warsaw). Nukleonika, 10: 321-30 (1965).

Changes in EPR spectra of gamma-irradiated crystals of β-succinic acid were studied after prolonged warming and at various temperatures. It was found that (I) HOOC–$\dot{C}$H–CH_2–COOH and (II) HOOC–CH_2–CH_2–$COO^{\cdot}$, stable at room temperature, are secondary radicals. A mechanism of formation of secondary radicals from primary ones is proposed. (auth)

390 THE ACTION OF IONIZING RADIATION ON DILUTE AQUEOUS SOLUTIONS. Boag, J. W. (Inst. of Cancer Research, Sutton, Surrey, Eng.). Phys. Med. Biol., 10: 457-76(1965).

The phenomena of solvated and hydrated electrons in aqueous solutions such as water and liquid ammonia are discussed. The effects of dissolved oxygen on irradiated solutions are also considered. Examples are given to illustrate the power of new methods of studying radioinduced reactions in solution. (P.C.H.)

391 POLYMER SOLUTIONS AS RADIATION DOSEMETERS. Raju, M. R. (Massachusetts General Hospital, Boston). Phys. Med. Biol., 10: 515-24(1965).

The use of polymer solutions of polyacrylamide and polyisobutylene as dosemeters, and their stability, are discussed. These solutions offer a simple and convenient method of measuring absorbed doses. The response in the range 10^2 to 10^5 Rad is the same for γ and proton radiations, independent of energy, with limited dose rate dependence. Both polymers are insensitive to thermal neutrons and hence offer a very convenient method of estimating γ doses in the presence of neutrons. (auth)

392 RADICAL AND MOLECULAR YIELDS IN THE γ-RADIOLYSIS OF WATER. II. THE POTASSIUM IODIDE-NITROUS OXIDE SYSTEM IN THE pH RANGE 0 TO 14. Buxton, G. V.; Dainton, F. S. (Univ., Leeds). Proc. Roy. Soc. (London), Ser. A, 287: 427-43(Sept. 28, 1965).

The yields of H_2, O_2, N_2, I_2 and H_2O_2 for ^{60}Co γ-irradiation of aqueous solutions of potassium iodide containing N_2O were measured at eleven values of pH in the range 0.1 to 14. As the pH is increased $G(N_2)$ increases from 0.25 at pH 0.1 to 3.2 at pH 4 remaining constant to pH 10.8 when it again increases to 4 at pH 14. $G(I_2)$ decreases from 1 at pH 0.1, passes through a minimum of 0.65 at pH 1.1, then increases to a constant value of 2.3 in the range $4 < pH < 11$, thereafter increasing to 3.8 at pH 14. $G(H_2)$ falls from 1.1 at pH 0.1 to a constant value of 0.4 at pH $\geq$ 2, and $G(H_2O_2) + G(O_2)$ is constant at 0.6 from pH 0 to 10, thereafter declining slowly to 0.34. These and other data which are presented are interpreted on the basis that $G_{e^-_{aq}} = 2.3$ and $G_H = 0.6$ over the whole pH range and that excited water molecules are also formed which can react with N_2O ($\rightarrow N_2 + 2OH$), with OH^- ($\rightarrow e^-_{aq} + OH$), with H^+ ($\rightarrow H_2^+ + OH$) and that O^-, OH and H_2^+ oxidize iodide ions whereas H reduces I_3^-. Thus the available conventional radical yields G_H and G_{OH} increase with either increasing electron scavenger concentration, e.g., O_2 and N_2O, or increasing $[H^+]$ or $[OH^-]$. Radical and molecular yields for alkaline solutions obtained by other methods are reviewed. (auth)

393 RADICAL AND MOLECULAR YIELDS IN THE γ-RADIOLYSIS OF WATER. III. THE NITROUS OXIDE-SODIUM TELLURITE SYSTEM. Dainton, F. S.; Rumfeldt, R. (Univ., Leeds). Proc. Roy. Soc. (London), Ser. A, 287: 444-56(Sept. 28, 1965).

The yields $G(H_2)$, $G(O_2)$, $G(N_2)$, $G(H_2O_2)$ and $G(Te^{VI})$ were measured at different doses for ^{60}Co γ irradiated aqueous alkaline (pH > 10.4) solutions of sodium tellurite containing either oxygen or nitrous oxide or no dissolved gas. Where possible, material balances were obtained and $G(H_2) = 0.40$ was independent of dose, solute concentration and pH and is believed equal to G_{H_a}. Reasons are given for considering that $G_{H_2O_2} = 0.60$ in these systems. Tellurite ions react with solvated electrons and $k(\mu = 0.24) = 5.8 \times 10^8 M^{-1} s^{-1}$. The ratio $k(e^-_{aq} + Te^{IV})/k(e^-_{aq} + N_2O)$ varies from 0.10 at pH 12.6 to 0.53 at pH 14.0 suggesting that the predominant form of tellurite ion is TeO_3^{2-}. These and other data indicate that an increase of pH in the range 11 to 14 causes each of the yields of reducing and oxidizing radicals to increase by one unit but those of H_2 and H_2O_2 are unchanged. $G(Te^{VI})$ for oxygenated tellurite solutions is dependent on both oxygen concentration and dose which precludes the use of this system as a reliable method for determination of radical yields in aqueous alkaline solutions. (auth)

394 ENERGY DEPENDENCE OF FREE RADICAL PRODUCTION IN ALANINE. Ebert, P. J. (USAF School of Aerospace Medicine, Brooks AFB, Tex.); Hardy, K. A.; Cadena, D. G. Radiat. Res., 26: 178-97(Oct. 1965).

Studies showed that the amino acid dl-alanine can be used as an accurate dosimeter, sensitive to directly and indirectly ionizing radiations. The resolvable energy response

for charged particles parallels that of an organic scintillator, and the energy response to γ rays and x rays is flat from below 40 kev to 1.25 Mev, the highest photon energy used. Conditions of high vacuum show no decrement in radioinduced signal. The average atomic number and atomic percentages of alanine are nearly equal to those of tissue, indicative that such a system would minimally perturb a radiation field in the measurement of a radiation dose. (auth)

395 RADIATION-INDUCED ADDITION REACTION OF ETHERS TO FLUORINE-CONTAINING OLEFINS. Muramatsu, Hiroshige; Inukai, Kan (and others) (Government Ind. Res. Inst., Nagoya, Japan). Rept. Govt. Ind. Res. Inst., Nagoya, 14: 213-19(June 1965). (In Japanese).

The radioinduced addition reactions of tetrahydrofuran, dioxane, and diethyl ether to chlorofluoroolefins such as 1, 2,2-trichloro-2-fluoroethylene, 1,2-dichloro-1,2-difluoroethylene, and 1,1-dichloro-2,2-difluoroethylene were carried out. While the addition of tetrahydrofuran and dioxane gave mainly 1:1 adducts in appreciable yields, diethyl ether added to the olefins to give a 1:1 adduct and a 1:2 adduct in a molar ratio of about 1:1. The structures of the adducts were determined by proton nmr spectroscopy. (NSA of Japan)

396 RADIOLYSIS OF ESTRONE AND ESTRADIOL. Wheeler, Owen H.; Montalvo, Rafael (Puerto Rico Nuclear Center, Mayaguez). Science, 150: 493-4(Oct. 22, 1965).

Gamma irradiation of estrone and estradiol in 1N aqueous sodium hydroxide resulted in the formation of 2-hydroxyestrone and 2-hydroxyestradiol, respectively. Estrolactone (16a-oxa-D-homoestrone) was not encountered. (auth)

397 NEW PHOTOCHEMICAL, RADIATION CHEMICAL, AND THERMAL MODES OF FORMATION OF PHENANTHROXAZOLES. Pfundt, G.; Hardham, W. M. (Max-Planck Institut fuer Kohlenforschung, Muelheim-Rhur, Ger.). Tetrahedron Letters, No. 28: 2411-15(July 1965). (In German).

Irradiation of the monoimine of phenanthrene-9,10-quinone in methyl-substituted aromatics in the absence of O_2 led to the production of 2-arylphenanthroxazoles. Either light or ^{60}Co γ radiation may be used. Suitable aromatics include toluene, o-xylene, m-xylene, p-xylene, mesitylene, and 2-methylnaphthalene. For suspensions of the imine in the aromatic, G was found to be 0.3. In a 1:5 mixture of the aromatic solvent and benzene, G was 0.05. Thus benzene did not sensitize the reaction. The yield of the photochemical reaction was 30%; the figure suggested that two molecules of imine consume the 4 H atoms given up by each molecule forming the product. The radiochemical yield was 70% maximum. Oxygen had no effect on the yield. Apparently abstraction of H followed another mechanism in the radiochemical case. The reaction was thus one of the few in which the radiation chemical method is preferable to the photochemical method. (BBB)

398 RADIATION POLYMERIZATION OF DIKETENE IN THE SOLID AND LIQUID STATES. Ushakov, V. D.; Matveeva, A. V.; Slovokhotova, N. A.; Khomikovskii, P. M.; Abkin, A. D. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1165-70(July 1965). (In Russian).

The structure of polymers of diketene formed by the γ-ray induced bulk polymerization at −78.0 and 25°C and doses up to 70 Rad/sec and also in tetrahydofuran solution at 0° was investigated by ir spectroscopy. It was found that the radiation polymerization of diketene in the crystalline state at −78° proceeds with the formation of linear polymers. Besides the basic units with the structure of a polyester the polymers also contain a certain amount of units of the tautomeric form. The radiation polymerization of diketene in the liquid state or in solution proceeds mainly with the formation of a polymer containing β-lactone groupings. Ring opening also occurs in the polymerization process. (auth)

399 RADIATION POLYMERIZATION OF DIPHENYLVINYLPHOSPHINE IN THE SOLID STATE. Chikishev, Yu. G.; Tsetlin, B. L.; Rafikov, S. R. (Inst. of Organic Compounds, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1179-83(July 1965). (In Russian).

The radiation polymerization of diphenylphosphine oxide in the solid state is a fundamentally new type of solid phase polymerization. The process proceeds in a homogeneous medium until complete conversion of the monomer into a polymer with the formation of solid solutions exists, the outer facets and transparency of the original monocrystals being retained. (auth)

400 THE ACTION OF FAST ELECTRONS ON THE STRUCTURE OF POLYVINYLCHLORIDE. Slovokhotova, N. A.; Sadovskaya, G. K.; Vasilev, L. A.; Kargin, V. A. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1306-9(Aug. 1965). (In Russian).

The effect of ionizing radiation on the structure of poly (vinyl chloride) was studied by infrared spectroscopy. Irradiation was carried out in vacuum at 20 or −196°C with fast electrons from an electron accelerator source with 400 to 800 Mrad doses. It was found that irradiation caused: dehydrochlorination to form isolated or conjugated vinylene double bonds, break of the backbone to form end-group double bonds and methyl groups, and aromatic system formation. The nature of the structural changes depended on the irradiation temperature. For example, irradiation with 800 Mrad at 20°C caused an increase in the conjugated double bond concentration and the appearance of aromatic systems. (CFSTI)

401 THE DENSITIES OF RADIATION GRAFT COPOLYMERS. Usmanov, Kh. U.; Tillaev, R. S.; Musaev, U. N. (Tashkent State Univ.). Vysokomol. Soedin., 7: 1310-13(Aug. 1965). (In Russian).

The densities of graft copolymers obtained by the radiation grafting of acrylonitrile on polystyrene, polyvinylchloride, perchlorovinyl, and polyvinylalcohol were determined by a hydrostatic method. It was shown that the densities may be both greater or less than the mean densities of the polymer components. (auth)

402 CHARACTERISTICS OF THE RADIATION CROSSLINKAGE OF SOME POLYOLEFINS AND THEIR COPOLYMERS IN N_2O MEDIUM. Karpov, V. L.; Leshchenko, S. S.; Mitrofanova, L. V.; Finkel, E. E. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR; Research Inst. of Cable Industry, USSR). Vysokomol. Soedin., 7: 1319-22(Aug. 1965). (In Russian).

The effect of nitrous oxide on the radiation crosslinking of polyethylene, polypropylene, and ethylene-propylene copolymer was investigated by an extraction method. It is shown that nitrous oxide exerts an accelerating effect on the radiation crosslinking of polyolefins. The sensitization of the crosslinking process was found to be due to suppression of degradation. (auth)

403 γ-RAY INDUCED POLYMERIZATION OF ISOBUTYLENE IN THE PRESENCE OF SOLIDS. Kristal'nyi, E. V.; Medvedev, S. S. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1377-82(Aug. 1965). (In Russian).

The radiation polymerization of isobutylene at −78°C in the presence of solid additives was investigated. Most of the additives increased the polymerization rate, while the molecular weight of the polymer remained unchanged. The polymer yield increased linearly with increases in surface area of the solid additive. The copolymerization of isobutylene with vinylidene chloride at 0, −39, and −78°C in the presence of zinc oxide was studied and the monomer reactivity ratios were calculated. At all temperatures the copolymers were enriched in isobutylene as compared with copolymers obtained in the presence of ZnO. The polymerization of isobutylene in the presence of ZnO was investigated over a wide range of temperatures (from 0 to −127°C). The polymer yield in all cases increased, whereas the molecular weight did not vary. The molecular weight increased with decreases in temperature. More thoroughly purified isobutylene polymerized at higher velocities (both in the presence of ZnO and without additives). (auth)

404 RADIATION POLYMERIZATION OF METHYL ACRYLATE IN ETHYL CHLORIDE SOLUTION. Rozovskaya, N. N.; Sheinker, A. P.; Abkin, A. D. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1383-7(Aug. 1965). (In Russian).

The rate of polymerization of methyl acrylate by γ rays in ethyl chloride and the molecular weight of the resultant polymers decreased with decreasing temperature over the range from 25 to −116°C. The over-all activation energy of polymerization was ~2.5 kcal/mole. The polymerization rate at 25 and −78°C was proportional to $I^{0.5}$. The results obtained indicated a radical mechanism for the radiation polymerization of methyl acrylate in ethyl chloride over the temperature range investigated. The copolymers of methyl acrylate and acrylonitrile and of methyl acrylate and styrene formed in ethyl chloride at 0 and −78°C were close in composition to the copolymers formed in the radical polymerization: r_1 (methyl acrylate) = 0.9 and r_2 (acrylonitrile) = 1.1; r_1 (methyl acrylate) = 0.07 and r_2 (styrene) = 0.9. The polymerization of methyl acrylate at 0 and −78°C was inhibited by small additions of styrene and acrylonitrile. Inhibition by acrylonitrile was especially appreciable at −78°C. The polymerization rate of styrene at −78°C also decreased in the region of low methyl acrylate additions. The copolymerization of methylacrylate with styrene and acrylonitrile in ethyl chloride proceeded at 0°C according to a radical mechanism; at −78°C ionic reactions became of some importance. (auth)

405 RADIATION POLYMERIZATION OF METHYL ACRYLATE IN TRIETHYLAMINE AND TETRAHYDROFURAN SOLUTION. Rozovskaya, N. N.; Sheinker, A. P.; Abkin, A. D. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1388-93(Aug. 1965). (In Russian).

The rate of radioinduced polymerization by γ rays of methyl acrylate in triethylamine solution (25 to −116°C) and in tetrahydrofuran (25 to −78°C) decreased with decreasing temperature. Depending on the solvent species and the monomer concentration the over-all activation energy was 1 to 2.5 kcal/mole. The molecular weight of the resultant polymer decreased sharply in triethylamine at −78°C. The polymerization rate at 25 and −78°C in triethylamine solution was proportional to $I^{0.9}$ and in tetrahydrofuran to $I^{0.6}$. Diphenylpicrylhydrazyl and benzoquinone inhibited the polymerization of methyl acrylate in triethylamine solution at −78°C, whereas ethyl chloride had no inhibiting effect on the polymerization in triethylamine and tetrahydrofuran at −78°C. It was concluded that polymerization of methyl acrylate in solution and in particular in triethylamine is inhibited by the solvent molecules due to chain transfer. (auth)

406 DYNAMIC DETERMINATION OF ELASTICITY CONSTANTS OF POLYMERIC MATERIALS IRRADIATED BY γ-RAYS AND FAST ELECTRONS. Kurilenko, A. I.; Tatarenko, O. F.; Karpov, V. L. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1422-6(Aug. 1965). (In Russian).

The effect of ionizing radiation on the dynamic elasticity constants of hardened polyesters, polymethyl methacrylate, and polyvinyl chloride at room temperature was investigated. In a field of ^{60}Co γ rays for a dose rate of up to 800 rad/sec and in a field of accelerated electrons at dose rates up to 1.5 Mrad/sec no reversible changes in the shear modulus and the elasticity of the polymeric materials were revealed. (auth)

407 DIFFUSION OF GASES IN POLYMERS EXPOSED TO IONIZING RADIATION. Savin, A. G.; Vaisberg, S. E.; Karpov, V. L.; Tikhomirova, N. S. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1427-9(Aug. 1965). (In Russian).

It is shown that gas diffusion through polymers was not accelerated by irradiation. This finding was in contrast to the results of Tikhomirova, Malinskiy, and Karpov (Vysokomol. Soedin., 2: 1349, (1960)). The diffusion of argon, helium, and nitrogen in polyethylene irradiated with ionizing radiation (γ rays from a ^{60}Co source or 300-kev electrons) at 0 and 17 to 19°C at dose rates from 400 to 10,000 rad/sec was studied. (CFSTI)

408 MECHANISM OF THE RADIATION POLYMERIZATION OF DIPHENYLVINYLPHOSPHINE OXIDE. Chikishev, Yu. G.; Zetlin, B. L.; Rafikov, S. R. (Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1489-94(Sept. 1965). (In Russian).

Kinetics of the radioinduced polymerization of diphenylvinylphosphine oxide in solvents with various electron exchanging properties and the dependence of the yield in the polymerization reaction on the presence of inorganic powders and inhibitors was investigated in order to determine the liquid phase polymerization mechanism of DPVPO. The results were compared with the correlations in the peroxide polymerization of DPVPO. It was concluded that the radioinduced polymerization of DPVPO in the melt and in solutions is of a radical nature. (auth)

409 THE RADIATION POLYMERIZATION OF ISOBUTYLENE IN VARIOUS SOLVENTS. Popova, A. I.; Sheinker, A. P.; Abkin, A. D. (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 7: 1597-1603(Sept. 1965). (In Russian).

The rate of γ-induced polymerization of isobutylene at −78°C in methylene chloride solution and in difluorodichloromethane was higher than on bulk polymerization and polymers of higher molecular weight were formed in difluorodichloromethane. The reaction was retarded in CF_4 and completely inhibited by acetone, tetrahydrofuran, and ethyl propyl ketone. (auth)

410 ELECTRICAL POLARIZATION IN LEAD SILICATE GLASS AFTER X IRRADIATION. Knechtel, Guenther; Scharmann, Arthur (Universitaet, Giessen, Ger.). Z. Angew. Physik., 19: 389-92(1965). (In German).

Lead silicate glass was irradiated with 90 kv x radiation with doses between 2×10^3 and 2×10^4 R. If the glass between two electrodes is heated to temperatures between 80 and 160°C, an electric field arising along the irradiation direction propels a current through the sample. The time behavior of this current, the effect of the heating temperature on its time behavior, and the entire heated charge was investigated as a function of the dose, the dose rate, the heating temperature, and the time between irradiation and heating. The origin of a polarization field was explained through the forward scattering of photo- and Compton electrons. At room temperature this field is stable since no charge carriers are available for charge equilibrium. If the samples are heated, electrons are thermally released from the color centers and move in this field. A polarization current was measureable whose time behavior verifies this mechanism. At higher temperatures a current of positive ions in the reverse direction is superimposed on this electron current. The interaction between the thermal bleaching of the centers and the ion current leads during the heating process to an ion reverse current. (tr-auth)

411 HEAT CONDUCTIVITY OF NEUTRON IRRADIATED LiF. Himmler, Ulrich; Peisl, Hans; Waidelich, Wilhelm (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Physik., 19: 468-73(1965). (In German).

The temperature dependence of the heat conductivity between 5 and 140°K was measured in neutron-irradiated LiF single crystals. From the wave length dependence of the phonon scattering, data were obtained on the lattice faults produced. The heat resistivity caused by the radiation damage was 5°K from 40 to 200 cm grd/w according to the radiation dose. On a comparison crystal the lattice constant modification produced were measured by x rays. Point lattice errors first occur. After an irradiation dose of 5×10^{16} neutron/cm^2 saturation occurs. By coprecipitation larger disorder ranges whose order of magnitude was estimated at 500 Å were produced. In radiation with more than 10^{16} neutron/cm^2 a reformation of the disorders occurs. (tr-auth)

412 THE EFFECT OF IONIZING RADIATION ON THE SYSTEM SULFUR DIOXIDE–OXYGEN. IV. THE DEPENDENCE OF THE G-VALUE ON THE DOSE RATE FOR OXIDATION OF SULFUROUS ACID TO SULFURIC ACID. Schrader, Richard; Fritsche, Bernd; Schoenherr, Siegfried. Z. Anorg. Allg. Chem., 339: 67-70(Sept. 1965). (In German).

The oxidation of 0.2 molar sulfurous acid by oxygen under influence of x and γ rays was studied with dose rates ranging of from 0.06 to $4.0 \cdot 10^6$ ev/ml · min. By approximation, a dependence was found experimentally of the initial yield of sulfuric acid upon the dose rate DL according to the equation $G(H_2SO_4) = k \cdot DL^{-\frac{1}{2}}$, which is based on a chain breaking mechanism of second order. (auth)

413 THE HETEROGENEOUS IRRADIATION CATALYSIS OF CARBON DIOXIDE [Thesis]. Dietz, Russell Noel. Brooklyn, Polytechnic Inst., 1964. 173p.

The application of semiconductor theory to chemisorption and catalysis is discussed briefly. Carbon dioxide was condensed on prepared samples of various oxide semiconductors and irradiated in a ^{60}Co gamma source for different total doses and at several dose rates, temperatures, and adsorbed CO_2 charges. The surface areas and CO_2 adsorption isotherms as well as the maximum allowable volume of CO_2 in the monolayer were determined by standard techniques. The chemisorbed products of decomposition, CO and O_2, as well as other gases were recovered with a Toepler pump at a temperature of 460°C, and the composition determined using a calibrated vapor fractometer. The results indicate that the best catalysts for the decomposition of CO_2 are insulators, then n-type, and lastly, p-type. The p-type NiO does not produce any CO in accord with semiconductor theory which indicates that the amount of chemisorbed H_2 on a p-type catalyst is negligible and also that oxidation of CO is favored on a p-type conductor. There are also indications of a transition from p → i type with CuO and Ni_3O_4. Energy transfer from the solid to the adsorbed gas monolayer was found to occur for all the solids investigated. And the temperature of irradiation only affects the reaction in as much as it alters the amounts of reactants and products adsorbed in the monolayer. (Dissertation Abstr.)

414 ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGED SINGLE CRYSTALS (thesis). Perry, James William. Boulder, Colo., Univ. of Colorado, 1964. 60p.

The electron spin resonance spectra of x-irradiated $Mg(H_2PO_2)_2 \cdot 6H_2O$ showed the principal long-lived species to be the HOP_2^- fragment. The paramagnetic moiety is stable at room temperature up to a year after irradiation and retains the same orientation in the unit cell as the undamaged molecule, although there may be a change in the HPH angle under radiation damage. The total hyperfine interaction tensor for the ^{31}P nucleus shows axial symmetry with the principal components, A = 1803 Mc and B = 1299 Mc. This leads to a contact term of 1467 Mc and a dipolar term, A_d = 336 Mc. The proton hyperfine interaction is quite large and essentially isotropic with a_H = 254 Mc. The deviations in the g values (g = 2.002 and g = 2.003) from the free spin value (g_0 = 2.0023) are small. These results show that the HPO_3^- radical is a "hybrid radical" and, unlike π-electron radicals, retains its irregular tetrahedral geometry. In order to investigate the general conclusions of second order or isovalent rehybridization theory, the electron spin resonance spectra of the $\cdot PO_3^=$ generated in x-ray-damaged $(NH_4)_2PO_3F \cdot H_2O$ was studied. The hyperfine coupling tensor shows axial symmetry with principal components A = 1839 Mc and B = 1420 Mc. This leads to a contact term of 1560 Mc and a dipolar term of 280 Mc. Comparison of s to p ratios shows that the $\cdot PO_3^=$ fragment formed by the breaking of a P–F bond has less s character than $\cdot PO_3^=$ fragments formed in x-ray damaged phosphite salts. This confirms, in this instance, isovalent rehybridization theory. It is also significant that the radical retains the electronic structure of the molecule. The g values were found to be g = 2.000 and g = 2.001. (Dissertation Abstr.)

415 IRRADIATION POLYMERIZATION OF COMPRESSED PARTICULATE TRIOXANE. Doyle, Carroll F.; Helmlinger, Harry C. Jr. (to W. R. Grace and Co.). U. S. Patent 3,202,597. Aug. 24, 1965. Filed June 24, 1963.

A process is described for the preparation of finely divided fibrous polyoxymethylene by first compressing particulate trioxane under a pressure of at least 500 psi to obtain a coherent sheet having a thickness of from about 0.2 to 1.0 cm and then polymerizing the sheet using high-energy ionizing radiation as the polymerization initiator. Following the irradiation, the polymer is held at a temperature above 30°C but below the melting point of the trioxane monomer to permit complete polymerization to take place. The polymerized sheet is ground or milled by conventional methods to obtain the finely divided polyoxymethylene polymer. The fibers have a major dimension of less than 50 μ and a length-to-diameter ratio of greater than about 10 : 1. To minimize oxidation occurring at the polymerization sites, the irradiation and polymerization may be carried out in an inert atmosphere. (B.L.M.)

Radiochemistry

See also Separation Processes and Procedures

Refer also to abstract 231.

416 (NP–15525) PREPARACION DE FUENTES SIMULADAS DE ^{131}I. Informe No. 147. (Preparation of Sources of Mock ^{131}I. Note No. 147). Tenreyro, Elma A. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1965. 28p. Dep. mn.

The method of making and calibrating cylindrical standard sources of mock ^{131}I is described. These sources can be used for measurements with scintillation counters (sodium-iodide cylindrical and well detectors) and well type ionization chambers. They are prepared with a mixture of ^{133}Ba and ^{137}Cs and metallic filters, and are useful for ^{131}I determinations in liquid samples. (auth)

417 (NYO–3086-1, Pt.IX) ANALYTICAL DEVELOPMENT. Petrow, Henry G.; Cover, Arthur; Cohen, N. (New York Univ., N. Y. Inst. of Environmental Medicine). 9p.

Two new radiochemical procedures were developed, one for ^{90}Sr and one for ^{210}Pb. The procedures are rapid and precise, and have broad applications to environmental samples. (auth)

418 DETERMINATION OF ANODIC HYDROGEN–DEUTERIUM SEPARATION FACTORS ON NOBLE METAL ELECTRODES. Lauer, H.; Vielstich, W. (Univ., Bonn). Ber. Bunsenges. Physik. Chem., 69: 538-50(1965). (In German).

The isotope effect in the anodic oxidation of hydrogen was investigated. The change in gas composition of a circulating gas mixture was followed as a function of time for different electrode potentials. The results obtained were compared with anode current-voltage curves for hydrogen and deuterium. For rapidly rotating platinum or gold electrodes it was found that the anodic separation factor lies close to unity, i.e., that there is practically no fractionation. From the corresponding current-voltage curves (at different rotation velocities) it was concluded that absorption and/or dissociation of H_2, HD, and D_2 molecules is the rate-determining process, which is of approximately the same speed for these molecules. By use of membrane electrodes permeable to hydrogen (palladium/silver and palladium/platinum alloys) with palladium on the gas side it was possible to accelerate the preceding reactions (adsorption and dissociation) to such an extent that the anodic oxidation became the slowest step. A difference in oxidation velocity together with a shift of the isotopic ratio between gas and metal phase led to a separation factor between 1.3 and 2. (auth)

419 A DISCUSSION OF THE pH DEPENDENCE OF THE HYDROGEN-DEUTERIUM EXCHANGE OF PROTEINS. Hvidt, Aase (Univ. of Copenhagen). Compt. Rend. Trav. Lab. Carlsberg, 34: 299-317(1964).

The rate of H-D exchange in proteins is strongly de-

pendent on temperature and pH, as shown in studies of lysozyme. A marked decrease in the number of hard-to-exchange H's in this protein was observed with increasing pH from pH 3 to 8.7, in apparent contradistinction to the resistance of the conformation of the protein to changes in pH as measured by other methods. Studies of other proteins have demonstrated a similar pH dependence of their H-D exchange, so that the phenomenon is fairly general. Two explanations of this phenomenon are examined. One is that the observed exchange rates of protein H atoms are essentially rates of opening of the protein conformations, exposing H atoms in their interior regions to solvent water. In this case the exchange rates measure an increasing motility of polypeptide chains of proteins with increasing pH. The other explanation presumes a higher motility of the proteins. In this case the exchange rates of protein H atoms are proportional to the exchange rates of corresponding hydrogen atoms in structureless peptides. The exchange rate constants measure the free energy of the conformational transitions in the proteins, which expose the relevant H atoms to solvent water. Reasons for favoring the second explanation are given. However, the lack of any method which permits estimates of changes less than 1% in the stabilization energies of protein conformations or of their motility makes it impossible to decide definitely between these two explanations. A model for the H-D exchange in protein molecules is presented and mathematical formulations of the kinetics of the process are derived. (BBB)

420 INFLUENCE OF MOLECULAR WEIGHT ON THE RADIOLYTIC YIELD OF DESOXYRIBONUCLEIC ACID IN THE SOLID PHASE. Van de Vorst, A.; Villee, F.; Duchesne, J. (Universite, Liege). Intern. J. Radiation Biol., 9: 269-74(1965). (In French).

The electron spin resonance method is used to determine the dependence of the free radical yield on the molecular weight of DNA, when this solid state compound is irradiated by x-rays. It is shown that the greater the molecular weight, the lower the free radical yield, and this correlation is also found in the case of polyethylene and of polyacrylonitrile. On the other hand, a comparison of the free radical yields for nucleotides and DNA's of different sizes leads to infer the existence of radiochemical selection of the latter, during their molecular evolution in the prebiotic phase. It is suggested that this effect might be one of the factors governing the high molecular weights observed in vivo. (auth)

421 FREE-RADICAL FORMATION IN IRRADIATED DEOXYRIBONUCLEIC ACID. Ormerod, M. G. (Royal Military Coll. of Science, Swindon, Eng.). Intern. J. Radiation Biol., 9: 291-300(1965).

Electron-spin-resonance spectroscopy was used to study free radical formation in irradiated DNA, DNA containing bromo-uracil, RNA, thymine, uracil and related compounds. Radical yields were measured both at 77°K and room temperature. It was found that: the free radicals in DNA were not formed preferentially on the thymine residue; the replacement of thymine by bromo-uracil in DNA increased the radical yield but the increase was insufficient to account for the observed increase in radiosensitivity in cells; and that room temperature irradiation produced twice as many radicals in DNA as irradiation at 77°K which correlated well with the observed temperature effect in dry phage. (auth)

422 ^{18}O EXCHANGE REACTIONS BETWEEN GASEOUS OXYGEN AND CERTAIN OXYGEN-CONTAINING INORGANIC SALTS. Shakhashiri, B. Z.; Gordon, G. (Univ. of Maryland, College Park). J. Inorg. Nucl. Chem., 27: 2161-9(Oct. 1965).

Rate measurements were carried out on the ^{18}O exchange reaction between oxygen gas and certain alkali metal chromates, molybdates, tungstates, phosphates, and sulfates in the 600–850°C temperature range. It was observed that the rate of exchange was influenced by the nature of the cation and the nature of the central atom. In the alkali metal chromate series, the potassium salt exhibited the least tendency to exchange, but the activation energy for the exchange process was observed to decrease with an increase in the cation radius. In contrast, both the rate of exchange and the activation energy decreased as the effective nuclear charge of the central atom increased, as the central atom-oxygen bond distance decreased, and as the oxidation state of the central atom increased. A mechanism is proposed for the exchange reaction and a correlation between the rate of exchange and various thermal and thermodynamic properties is presented. (auth)

423 SYNTHESIS OF ^{3}H OR ^{32}P LABELED O,O-DIMETHYL S-(METHYLCARBAMOYLMETHYL)PHOSPHORODITHIOATE AND THE CHROMATOGRAPHY OF ITS RELATED COMPOUNDS. Uchida, Tetsuo (Sankyo Co., Ltd., Japan). J. Pharm. Soc. Japan, 85: 638-41(July 1965). (In Japanese).

O,O-Dimethyl-S-(methylcarbamoylmethyl) phosphorodithioate (Dimethoate) (I) was synthesized and labeled with tritium in the CH_3O position for metabolic studies. All the reactions were carried out in one flask, without transfer of the radioactive solution to other vessels, in order to avoid loss of radioactive compounds and to keep operator free from danger. Syntheses of compounds related to I are also described. Paper chromatography was carried out to separate seven compounds related to I. (NSA of Japan)

424 BEHAVIOR OF IODINE RELEASED IN CONTAINMENT VESSELS. Kaplan, S. I. Nucl. Safety, 5: No. 3, 254-61(Spring 1964).

Work reported on the behavior of I_2 at concentrations below those postulated in major accidents to U. S. power reactors is reviewed. British studies on optimum absorber systems are also discussed. Information is included on removal of I_2 from containment vessels, release of deposited I_2 by exchange processes, analysis of particulate behavior, and I_2 transport in laboratory rooms. (J.R.D.)

425 RADIOMETRIC DETERMINATION OF ION SELF-DIFFUSION MOBILITIES. I. METHOD AND RESULTS FOR DILUTE SOLUTIONS OF ALKALI METAL CHLORIDES. Dorabialska, Alicja; Plonka, Andrzej (Technical Univ., Lodz, Poland). Nukleonika, 10: 213-19 (1965).

The development of the radiometric method of ion self-diffusion mobilities comparison and results for dilute solutions of alkali metal chlorides having suitable γ-emitting radioisotopes are presented. (auth)

426 ENERGY LOSS AND RESULTANT CHARGE OF RECOIL PARTICLES FROM ALPHA DISINTEGRATIONS IN SURFACE DEPOSITS OF ^{210}Po AND ^{241}Am [Thesis]. Cano, Gilbert Lucero. Albuquerque, N. Mex., Univ. of New Mexico, 1964. 78p.

Energy loss and resultant charge of the recoil ions from alpha disintegrations of ^{210}Po and ^{241}Am deposited on Pt backing were determined experimentally both by means of a magnetic spectrometer and by a hemispherical ionization chamber. In thin sources the recoils lose energy exponentially with source age. The energy degradation increases with source thickness. Approximately 78% of the ^{206}Pb recoils occur singly and 22% doubly ionized. The ^{237}Np recoils were missing 12 ± 2 electrons and had (65 ± 15) kev of kinetic energy. The large number of secondary particles released depends on source specific activity and age. (TCO)

427 THE BEHAVIOR OF RADIOACTIVE ELEMENTS PRODUCED BY ALPHA DECAY IN VARIOUS GASES [Thesis]. Wang, Agnes Shih-chuen Chia. Urbana, Ill., Univ. of Illinois, 103p.

Investigations of radioactive ^{212}Pb and ^{212}Bi, produced in the ^{220}Rn decay chain, using standard vacuum line and counting techniques, showed these elements behaving like aerosols in the carrier gases used. The aerosol apparently was formed by a combination of processes, including the dispersion method by which ^{220}Rn was extracted from the thorium source. The source radiation contributed by producing various radiation damage products that acted

as condensation nuclei for the aerosols. The lead and bismuth produced by alpha decay were attached to the aerosol particles. Different aerosol activities were obtained in various carrier gases. They were highest in argon, next highest in carbon monoxide and methane, and very low in helium and hydrogen. This is interpreted in terms of the difference in gas properties. Filtration experiments with Millipore filters, fibrous filters, and sintered glass filters were performed. Electrostatic precipitation indicated that the aerosols were positively charged. (TCO)

428 MOBILE RADIOISOTOPE LABORATORY. (Engineering Materials). (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). (CAPE-1244).

9 drawings.

The mobile laboratory described is contained in a trailer of the "frameless" type with structural steel components, which have a tensile strength of not less than 75,000 psi. The trailer has three partitions: one between the rear compartment and laboratory; one between the laboratory and the counting room; and one between the counting room and the office. The two air conditioners may be easily removed for repair and maintenance. The counting room is equipped for 8 students. The laboratory contains 3 fume hoods and other laboratory equipment. It is designed to be used as a laboratory and classroom to train college students in the application and handling of radioisotopes. (For details, see TID-4100) (M.C.G.)

Separation Processes and Procedures

See also Analytical Procedures
ISOTOPE TECHNOLOGY — Separation and Production

429 (BNWL-69) PARAMETRIC EVALUATION OF DTPA, EDTA, AND HEDTA FOR ION EXCHANGE PURIFICATION OF PROMETHIUM. Wheelwright, E. J.; Myers, T. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1965. Contract AT (45-1)-1830. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Optimum conditions for the purification of the individual light rare earth elements by ion exchange elution were determined for the eluting agents DTPA, EDTA, and HEDTA. The conditions apply directly to the production of macro amounts of pure promethium. DTPA was demonstrated to be superior to both EDTA and HEDTA with feed solutions which do not contain significant amounts of Pb^{+2} or Y^{+3}. In the event that Pb^{+2} or Y^{+3} are present, EDTA or a sequence of first DTPA and then EDTA gives better results than DTPA alone. Because of the much higher separation coefficient of promethium from cerium in the DTPA system and its use of a H^+ retaining ion, an initial fast "rough" separation would be made with DTPA to reduce radiolysis from ^{144}Ce and to permit a reduction in column size for subsequent columns. All three eluting agents can be used in the same equipment. The column equipment is described and a flowsheet proposed for a separation plant capable of producing 6×10^6 C of high purity promethium per year on a 10 months per year operational basis. (auth)

430 (CEA-R-2823) ETUDE DE LA DECONTAMINATION DU CUIVRE ET DES LAITONS EN PRESENCE D'ULTRA-SONS. (The Ultrasonic Copper and Brass Decontamination Study). Courtault, Jeannine; de Kerdelleau, Jean; Mestre, Emile (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1965. 20p. Dep. mn.

The use of ultrasonics as a decontamination technique does not bring an absolute solution. It seemed necessary to find what were the optimum conditions for using the ultrasonics and to define not only the ultrasonic factors but also the chemical solutions which bring some appreciable decontamination factors without bringing any too important corrosion processes. Results are presented of this study applied to copper and brass. This study allowed one to select some effective treatment baths for two types of contamination: plutonium and fission products. (auth)

431 (CONF-651103-7) NUCLEAR SAFETY CONTROL IN THE CHEMICAL PROCESSING FACILITIES OF THE SAVANNAH RIVER PLANT. Forstner, James L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Sept. 1965. Contract AT(07-2)-1. 17p. (SM-70/40). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

For Presentation at IAEA Symposium on Criticality Control of Fissile Materials, Stockholm.

A survey is given of the nuclear safety controls used at Savannah River. Administrative, basic, and operational controls are covered. A brief description is given of the Purex and enriched uranium processes, both of which use TBP–kerosene solvent. The controls used in the dissolving and feed clarification, solvent extraction, solvent recovery, plutonium finishing and recovery, and receiving basin for off-site fuels are described. (D.L.C.)

432 (EURAEC-1402) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 10, October 1–December 31, 1964. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contract 004-64-4 RCIP. 52p. (EUR-2361). Dep. mn; CFSTI $3.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The preparation of a device to study PuF_6 formation and condensation conditions in the absence of a large F_2 gas flow is in progress. The installation is characterized by sharp hexafluoride condensation and very sensitive pressure measurement. Tests on U showed the possibility of condensing UF_6 on formation, and revealed various geometrical factors affecting the reaction rate. Studies were made on UO_2 (compact) $\xrightarrow{ClF_3}$ UF_6 cycles. Temperatures between 100 and 300°C give satisfactory chemical yields of ClF_3. It is not necessary to dilute UO_2 with Al powder. However, the presence of alumina has no noticeable affect on the reaction rate. This rate increases with the height of the UO_2 layer and with the ClF_3 flow. Study of the behavior of the fission products during the volatilization of U by ClF_3 showed that Nb is not volatilized; Ru is partly volatilized at 100°C; I_2, Te, and Np are partly volatilized at 50°C; at higher temperatures practically all I_2 is volatilized. UO_2 sintered with 2% of a synthetic mixture of inactive fission products was subjected to oxidation, hydrofluorination and F_2 fluorination. More rigorous temperature conditions are required, particularly for oxidation. A study of the reaction of UC with hydrofluoric acid in a fluid bed was started. During the transformation of UF_6 into UO_2 by electrolysis, it appears that the impurity content (alkaline and halogeneous) of the final product is noticeably reduced by molten chloride baths. (J.R.D.)

433 (INP-412/C) THE RADIOCHEMICAL SEPARATION OF SOME METAL IONS BY EXTRACTION CHROMATOGRAPHY ON POWDERED POLYTETRAFLUOROETHYLENE IN THE SYSTEM TRI-n-OCTYLAMINEELECTROLYTE. Mikulski, Jan (Institute of Nuclear Physics, Krakow (Poland)). June 1965. 12p. Dep.

The following ions were separated using extraction chromatography in the system TNOA-electrolyte: Tb(III), Hf(IV), Cd(II), and Zn(II) from U(VI); Ni(II) from Co(II) and Cu(II); Te(IV) from Sb(V); and Am(III) from Pu(VI). The radioactive indicators ^{60}Co, ^{63}Ni, ^{64}Cu, ^{65}Zn, ^{115}Cd, ^{124}Sb, ^{127m}Te, ^{181}Hf, ^{160}Tb, ^{235}U, ^{239}Pu, and ^{241}Am were used in the investigations. (auth)

434 (JUL-248-NP) UNTERSUCHUNG UEBER DIE MASSENSPEKTROMETRISCHE TRENNUNG VON SPALTPRODUKTEN. (Study of the Mass Spectrometric Separation of Fission Products). Armbruster, P.; Lawin, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik). Jan. 1965. 31p. Dep. mn.

The resolution of mass spectrographs that is necessary

for the carrier-free separation and for the study of the energy distribution of the fission products was investigated. The mass spectrographs suitable for the separation of fission products are described and compared. (J.S.R.)

435 (RFP-551) RECOVERY OF PLUTONIUM FROM MISCELLANEOUS ANALYTICAL LABORATORY WASTES. Molen, G. F. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Sept. 24, 1965. Contract AT(29-1)-1106. 28p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

A method for the recovery of plutonium from miscellaneous analytical laboratory wastes is described. Both oxalate precipitation and anion exchange were investigated as means of recovery. Oxalate precipitation is the preferred method of recovery. (auth)

436 (RL-SEP-518) SOLVENT EXTRACTION RECOVERY OF AMERICIUM WITH DIBUTYL BUTYL PHOSPHONATE. Kingsley, R. S. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 21, 1965. Contract AT(45-1)-1350. 35p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

A flow sheet for the recovery of americium from the Plutonium Reclamation Facility's aqueous waste (CAW) stream was developed and demonstrated in the laboratory. A study of the basic recovery chemistry showed the following: CAW can be neutralized to <0.05M H^+ without irreversible precipitation occurring. An extractant containing 30 vol% DBBP–70 vol% CCl_4 is an effective organic solvent for americium recovery. Americium extraction coefficients obtained with DBBP containing as high as 36% dibutyl methyl phosphonate impurity are comparable with those obtained with 99% pure DBBP. Dilution of DBBP with TBP drastically lowers the americium extraction coefficient. Dilution of neutralized CAW with 0.3M HNO_3 caused the americium coefficient to decrease rapidly. The order of effectiveness of NO_3^- metal salts added to the CAW to increase salting strength is $LiNO_3 > Mg(NO_3)_2 \cdot 6H_2O > Al(NO_3)_3 \cdot 9H_2O > NaNO_3 > Ca(NO_3)_2 \cdot 4H_2O$. Below 0.8M HNO_3, americium extraction coefficients increase rapidly with decreasing CAW acidity. Less than 0.1M F^- in CAW does not affect americium extraction. $NaNO_3$ and $Al(NO_3)_3$ are effective scrub-deentrainment reagents. Water and dilute HF are excellent agents for stripping americium from 30 vol% DBBP–70 vol% CCl_4. Greater than 90% of the plutonium entering a dibutyl butyl phosphonate solvent extraction flow sheet is retained by the organic phase through subsequent extraction-strip cycles. (auth)

437 (RT/CHI(65)21) THE EXTRACTION OF URANIUM AND PLUTONIUM FROM NITRIC ACID SOLUTION BY SECONDARY AND QUATERNARY AMMONIUM NITRATE SALTS. Danesi, P. R.; Orlandini, F.; Scibona, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Apr. 1965. 13p. Dep. mn.

The separation of Pu(IV) from U(VI) nitrate by selective extraction of Pu(IV) with a secondary or a quaternary ammonium nitrate salt dissolved in an organic diluent was investigated. The dependence of the separation on the concentration of uranium, nitric acid, and ammonium salt has been studied. A competitive effect of uranium in the extraction of plutonium was noticed. (auth)

438 (RT/CHI(65)23) DISSOLUZIONE DI ALLUMINIO E DI LAMINE MTR FREDDE IN CONDIZIONI ACIDE ED ACIDO-DEFICIENTI. PARTE I. DISSOLUZIONE IN PALLONE. (Aluminum and Aluminum–Uranium Alloy Plates Dissolution in Acid and Acid-Deficient Conditions. Part I. Preliminary Laboratory Studies). Beone, G.; Mazzoleni, G. P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1965. 32p. Dep. mn.

The behavior of aluminum and uranium–aluminum alloy plates in the mercury-catalyzed nitric acid dissolution for acid and acid-deficient final conditions is tested. The results of this work confirm the possibility of affecting batch dissolutions of aluminum plates for acid and acid-deficient final conditions with a reasonable dissolution rate. The mercury-catalyzed nitric acid dissolution of uranium–aluminum alloy plates in acid-deficient final conditions (<–1,2M) is not attractive, on a process basis, due to the long dissolution time and to the partial reduction of U(VI) to U(IV). (auth)

439 (ORNL-tr-893) THE SEPARATION OF AMERICIUM AND CURIUM BY ANION EXCHANGE WITH THE USE OF A SOLUTION CONTAINING A MIXTURE OF METHYL ALCOHOL AND NITRIC ACID AS THE ELUANT. Bochkarev, V. A.; Voevodin, E. N. Translated by S. J. Rimshaw and J. J. Pinajian (Oak Ridge National Lab., Tenn.) from Radiokhimiya, 7: 461-5(1965). 12p. Dep. mn; CFSTI $1.00 cy, $0.50 mn; JCL $1.60 fs, $0.80 mf.

The adsorption of americium and curium on AV-17 and Dowex 1, X8, anion resins from solution mixtures of methyl alcohol and nitric acid was investigated. It was found for the AV-17 resin, that on increasing the HNO_3 concentration from 0.1 to 1.6M and the CH_3OH concentration from 80 to 95% in the mixture, there was a significant increase in the distribution coefficients of americium and curium. The separation coefficient for a mixture of methyl alcohol and nitric acid, under the conditions studied, were large (2–3) as compared to the separation coefficients obtained with other more frequently used eluates such as citrate, lactate, and ammonium α-hydroxy isobutyrate. The separation coefficient changed only slightly on varying the nitric acid concentration from 0.1 to 1.6M. The distribution coefficients of americium and curium under these conditions varied by more than an order of magnitude. In order to save time the separation can be successfully carried out at low concentrations of nitric acid (0.1M). (auth)

440 NATURAL LEACHING OF URANIUM MINERALS. Cordero, G.; Josa, J. M. Energia Nucl. (Madrid), 9: 22-40(1965). (In Spanish).

Laboratory and field tests were made of the natural leaching of uranium minerals. The techniques used for both short-term and long-term studies and for the field experiments were described. The results are discussed and compared for the various types of leaching. The recovery of uranium from solutions by precipitation, ion exchange, and solvent extraction was investigated. A flow diagram for the beneficiation of minerals by natural leaching is given. (J.S.R.)

441 RESEARCH IN URANIUM REFINING. FUNDAMENTAL EXPERIMENTS IN LEACHING AND SOLVENT-EXTRACTING URANIUM FROM ITS ORE. Kinoshita, Hideo; Sato, Etsuo (and others) (Furukawa Electric Co., Ltd., Japan). Furukawa Elec. Rev., No. 33, 1-7 (Dec. 1963). (In Japanese).

Researches in refining indigenous uranium ore were made in regard to the sulfuric acid method. The ore produced in Japan is a low-grade one with a small uranium content, unlike foreign ores, so that uranium obtained from it is bound to be expensive. Thus research in uranium ore refining aims at development of an economical method through shortened process. A method of leaching by bicarbonate solution is used taking into consideration that the autunite contained in the indigenous uranium ore is soluble in weak alkali. Also, inquiries into potentialities of an integrated process of refining by solvent-extraction immediately after leaching have been made. (NSA of Japan)

442 FUSED-SALT FLUORIDE-VOLATILITY PROCESS FOR RECOVERING URANIUM FROM SPENT ALUMINUM-BASED FUEL ELEMENTS. Bennett, M. R.; Cathers, G. I.; Milford, R. P.; Pitt, W. W. Jr.; Ullmann, J. W. (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., Process Design Develop., 4: 387-94(Oct. 1965).

A molten-salt fluoride-volatility process for dissolving aluminum-based nuclear reactor fuel elements and recovering the uranium as UF_6 was demonstrated on laboratory and engineering scales. Aluminum–uranium alloy was dissolved in $KF–ZrF_4–AlF_3$ at 575°C by reaction with HF, and the uranium was then converted to volatile UF_6 with fluorine. Further purification steps were identical to those used in the Zr–U alloy process. Corrosion was studied. Pilot plant tests with irradiated fuel are under way. (auth)

443 FUSED-SALT ELECTROREFINING OF MOLTEN PLUTONIUM AND ITS ALLOYS BY THE LAMEX PRO-

CESS. Mullins, L. J.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Ind. Eng. Chem., Process Design Develop., 4: 394-400(Oct. 1965).

An extensive development program culminated in construction of a 40 kg per month capacity electrorefining plant. High-purity plutonium was produced in good yield from 0.2 to 3.5 kg. Impure plutonium metal, Pu–10 atom % Fe alloy and Pu–3 atom % Ga alloy, was refined routinely to plutonium containing less than 100 ppm by weight of metallic impurities. In addition to serving as a means of preparing high-purity plutonium metal, the process was used to recycle plutonium metal scrap economically. The theory of plutonium alloy electrorefining was developed. In particular the behavior of elements commonly present in impure plutonium metal, such as uranium, thorium, americium, iron, and gallium, was reviewed. Results were correlated with thermodynamic properties and phase diagrams of plutonium alloy systems. The effects of process variables such as refining temperature, current density, molten-salt electrolyte composition, and stirring are discussed. Various ceramics and refractory metals were evaluated as container materials for molten salts and molten plutonium. (auth)

444 A STUDY OF SECULAR EQUILIBRIUM USING ^{144}Ce–^{144}Pr. Semmelrogge, W. F.; Sicilio, Fred (Texas A and M Univ., College Station). J. Chem. Educ., 42: 427-8(Aug. 1965).

This report presents an experiment illustrating secular equilibrium in which the data can be obtained in a three-hr period; suggests solvent extraction as a rapid and simple method of separating ^{144}Ce and ^{144}Pr; proposes the use of count rate meter and recorder, if available, as substitutes for a scaler; and points out several features in the treatment of data. The decay scheme pertinent to this experiment is shown. The growth of ^{144}Pr is followed in the fraction containing initially pure ^{144}Ce. The decay scheme indicates that discrimination in counting will improve the quality of the data. Both ^{144}Ce and ^{144}Pr have mixed β-γ spectra, and it is desirable to count ^{144}Pr selectively. A γ spectrometer may be used, but in many laboratories, only Geiger detectors and scalers are available. Discrimination may be effected by use of absorbers. The data presented were obtained using a Geiger tube detector with a scaler, for the first set, and with a count rate meter and recorder, for the second set. A lead absorber of 520 mg/cm^2 was used to absorb most of the radiations from ^{144}Ce while transmitting appreciable intensities of the ^{144}Pr γ rays. Methyl isobutyl ketone (hexone) was used as the solvent. A stock aqueous solution of about 1 μC ^{144}Ce-^{144}Pr/ml was made 3M in HNO_3, and 1-3 ml of the stock solution was transferred to a separatory funnel. Then about 200 mg solid sodium bismuthate was added to oxidize Ce(III) to Ce(IV), and an equal volume of hexone was added. About 10 drops of the organic phase, containing ^{144}Ce, were transferred to a planchet, and several drops of dilute collodion added. Activity of the sample was counted every two min, each data point representing a one-min count starting 30 sec before the plotted time. (BBB)

445 ON THE SEPARATION OF URANIUM AND PLUTONIUM, STARTING FROM THEIR MIXTURES OF HEXAFLUORIDES. Regnaut, P.; Bourgeois, M. (Commissariat a l'Energie Atomique, Frankreich, France). Kerntechnik, 7: 388-94(Aug.-Sept. 1965). (In French).

Taking as a basis the great reactivity of the plutonium hexafluoride, the possibility of a selective reduction of this compound without deterioration of the uranium hexafluoride was studied. Uranium-plutonium separation of the gas-solid type resulted. The following chemical reagents were tried: H_2, SO_2, and freons 11, 12, 13, and 23. The reactions between these compounds and uranium and plutonium hexafluorides were followed by infrared spectrophotometry. It was recorded that H_2 and also, under certain conditions, SO_2 reduce uranium hexafluoride. The reactivity of freons decreased from freon 11 to freon 13. Freon 12 used at 150°C seemed to be the best compound for this separation. (auth)

446 ON THE REPROCESSING OF NUCLEAR FUELS BY LIQUID-LIQUID EXTRACTION WITH QUATERNARY AMMONIUM NITRATES. Koch, G. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 7: 394-9(Aug.-Sept. 1965). (In German).

For reprocessing of nuclear fuels, PUREX-type processes are presently used in most cases. In the reprocessing of high-burnup fuels, however, difficulties may possibly arise with this process. In searching for alternatives the possibility of reprocessing by extraction with long-chain quaternary ammonium nitrates was considered. Reasons for the choice of the extraction system are discussed. The extraction behavior of fissionable and fertile materials and of some fission products is reported. (auth)

447 SOLUBILITY OF URANIUM AND PLUTONIUM IN CADMIUM–ZINC–MAGNESIUM MELTS. Ammon, R. v.; Knighton, J. B.; Steunenberg, R. K. (Argonne National Lab., Ill.). Kerntechnik, 7: 400-3(Aug.-Sept. 1965). (In German).

In development work on liquid-metal processes for reprocessing a plutonium-bearing EBR-II fuel element, the solubilities of uranium and plutonium in cadmium-zinc-magnesium melts were determined. The solubility of uranium at 600°C was measured in solvents of all concentrations of the ternary phase diagram. In melts of high cadmium content (50 to 80 at. %) the temperature coefficient of the solubility is also given. These alloys showed the best uranium solubility (1 to 3 at. %). The solids in equilibrium with the melts are discussed. Several of the intermetallic phases were isolated and analyzed chemically and by x-ray diffraction. The solubility of plutonium in these solvents was generally higher than the uranium solubility by a factor of 3 to 6. (auth)

448 TRANSFORMATION THEORY OF THE SEPARATION CASCADES. IV. THE RECTANGULAR CASCADE. Troetsch, E.; Dickel, G. (Universitaet, Munich). Nukleonik, 7: 383-8(Aug. 1965). (In German).

The dimensions of cascades with constant cross section (rectangular cascades) that yield a given separation with minimum energy expenditure were studied. They can be reduced to the dimensions of the ideal continually stepped installations by means of two factors that are functions of the initial and final concentrations. The transformation theorem of the rectangular cascades was determined. They are the same as in the ideal cascades, however the transformation of the selectivity occurs as a new possibility. The impairment of the efficiency is only about 20% at small separations. Numerical values for the reduction factors and the utilization degree were given in curves or tables. (tr-auth)

449 CHROMATOGRAPHIC SEPARATION OF RARE EARTHS AND URANIUM FROM THORIUM. Gupta, S. S.; Mukerjee, D. (Lucknow Univ., India). Z. Anal. Chem., 213: 38-9(1965).

A chromatographic method for the separation of rare earths and uranium from thorium is described. Thorium forms no chelate with glycine, but rare earths and uranyl ions do form chelates with glycine. The chromatographic method is based on this property. (F.J.H.)

450 FLOTATION OF URANIUM FROM ELLIOT LAKE ORES. Honeywell, W. R.; Kaiman, S. (Dept. of Mines and Technical Surveys, Ottawa). 24p. (CONF-650326-1). Gmelin, AED-CONF-65-071-1.

From Canadian Inst. of Mining and Metallurgy, 67th Annual General Meeting, Toronto.

Laboratory and pilot plant flotation work on Elliot Lake ores is summarized. A ratio of concentration of from 2.5 to 3.5 to 1 is possible with satisfactory recovery. Data are presented in tables and graphs. Gravity-flotation techniques were found to be superior to the all-flotation procedure. Preliminary leach tests of the preconcentrate produced by the gravity-flotation circuit indicated that about 94% of the uranium in the preconcentrate could be recovered using current leaching procedures. It was con-

cluded that the loss of uranium to the tailing outweighs the advantages gained by preconcentration. (M.C.G.)

451 METHOD FOR LEACHING URANIUM-CONTAINING ORES. Mouret, Pierre; Pottier, Paul; Le Bris, Jean; Villa, Aiban (to Commissariat a l'Energie Atomique). German Patent 1,192,633. May 13, 1965. Priority date Nov. 5, 1958, France.

Ores with an uranium content of less than 1000 ppm are leached out by exposing them to the action of the diluted watery solution of an alkaline carbonate or bicarbonate for at least a month. The leaching solution is evenly distributed over the surface of the ore built up in layers at 0.5 to 5 l/hr m^2. The quantity of the leaching solution is chosen in such a way that it draws through the ore without a substantial flow or rinsing. (Gmelin Inst.)

452 METHOD FOR THE PRE-DECONTAMINATION OF NUCLEAR FUEL TO BE REPROCESSED. Vogg, Hubert; Baehr, Werner (to Gesellschaft fuer Kernforschung m.b.H.). German Patent 1,194,582. June 10, 1965. Filed Aug. 8, 1964.

The method comprises the steps of dissolving the fuel in an oxidizing alkaline melt, of leaching out the solidified melted body obtained with water or sodium hydroxide, of separating the dissolved iodate from the fuel precipitation, and of adding diluted acid to the remaining fuel. (Gmelin Inst.)

453 METHOD FOR THE EXTRACTION OF BERYLLIUM OXIDE FROM BERYLLIUM-CONTAINING ORES. Biermann, Wendell Josef (to Beryloy Ltd.). German Patent 1,195,731. July 1, 1965. Priority date Apr. 19, 1961, Canada.

The method comprises the steps of oxidizing the metallic ingredients of the ore by thermal treatment, and of dissolving the ground oxide mixture at 180°C in a concentrated beryllium salt solution like beryllium sulfate, nitrate, or chloride. (Gmelin Inst.)

454 METHOD AND DEVICE FOR ELECTROLYTIC DISSOLUTION DEPLETED URANIUM FUEL ELEMENTS. Raviv, Szmuel; Levin, Iddo (to Staat Israel). German Patent 1,196,377. July 8, 1965. Priority date May 6, 1963, Israel.

Fuel elements comprising a can of Al or an aluminium alloy and a nucleus of uranium or a uranium alloy are dissolved by electrolysis. The can is dissolved in an electrolyte consisting of an aqueous solution of sodium or potassium hydroxide the concentration being 15% by weight at most using a voltage of no more than 30 v between the anode and the cathode. For the dissolution of the fuel the alkaline solution is substituted by an aqueous solution of nitric acid which is chosen in such way that the uranium nucleus is dissolved electrolytically. (Gmelin Inst.)

455 METHOD OF REPROCESSING IRRADIATED NUCLEAR FUEL. Baehr, Werner (to Gesellschaft fuer Kernforschung m.b.H.). German Patent 1,199,748. Sept. 2, 1965. Filed May 15, 1963.

The method of reprocessing irradiated nuclear fuel (U, Pu) which contains metallic molybdenum comprises the steps of dissolving the irradiated fuel in an oxidizing alkaline melt and of leaching out the solidified melted material with water or sodium hydroxide. (Gmelin Inst.)

456 ELECTROLYTIC SEPARATION OF PLUTONIUM VALUES FROM URANIUM VALUES. Benedict, Glen E. (to U. S. Atomic Energy Commission). U. S. Patent 3,213,002. Oct. 19, 1965.

A method for the separation of plutonium values from uranium values by an improved electrolytic process is considered. An improvement in the plutonium separation factor to 13 to 160 and an increase in the bulk density were brought about by using a fused salt melt of equal molar lithium chloride and potassium chloride at a temperature of 600 to 625°C at a controlled cathode current density and by sparging the final electrolysis with a gas mixture of oxygen and chlorine. (AEC)

ENGINEERING

General

Refer also to abstract 1364.

457 (BMI-X-276) ANALYSIS OF INFORMATION ON REINFORCED OPENINGS IN PRESSURE VESSELS. Phase Report, February 12, 1963–February 11, 1964. Rodabaugh, E. C.; Atterbury, T. J. (Battelle Memorial Inst., Columbus, Ohio). Feb. 22, 1964. Contract W-7405-eng-92. 79p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Research effort during the period was devoted to accumulating, reading, and cataloging data for all types of reinforced openings in pressure vessels and pipelines, and intensive study of the available test data and theory for cylinder-to-sphere branch connections with internal pressure loading. It was found that the shell theory gives reasonably good stress-magnitude predictions for connections with an external fillet radius, r_0, approximately equal to the cylinder wall thickness, t, and connections with uniform-wall pad reinforcing on the cylinder or on the shell, provided the length of the reinforcing is greater than about $\sqrt{dt}$ on the cylinder and $\sqrt{RT}$ on the sphere, where d = cylinder diameter, t = cylinder wall thickness, R = sphere radius, T = sphere thickness. Stresses in cylinder-to-sphere connections with a significant amount of relatively compact, local reinforcing cannot be accurately predicted by use of Waters' shell theory or by semi-empirical modifications of it. For connections of the type indicated above, the Westinghouse "Seal-Shell-2" computer program (a multipiece-shell theory) can be used to provide reasonable predictions of stresses, provided the section thickness changes are not too abrupt. On the basis of limiting the maximum elastic surface stress to three times the nominal design stress, present code rules are unconservative for combinations of large d/D ratios with large D/T ratios where the reinforcement consists of a uniform increase in wall thickness of the sphere. (J.R.D.)

458 (NYO–2512-15) THE APPLICATION OF GAS-LUBRICATED BEARINGS TO HIGH SPEED, TURBO-MACHINERY. Final Report. Hinkle, J. G.; Fuller, D. D. (Franklin Inst. Research Labs., Philadelphia, Pa.). June 30, 1965. Contract AT(30-1)-2512. 39p. (F-A2392-3). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Information was obtained on the operation of a tilting-pad self-acting bearing in a test rig at super- and subatmospheric ambient pressures from 5 to 80 psia at speeds up to 21,000 rpm. The pivot pressure and film thickness were measured and compared with theoretical predictions. No direct correlation was obtained for the minimum film thickness, owing to the rotor bearings being designed for operation at standard atmospheric ambient conditions. During operation at conditions other than the optimum design conditions, the machine was insensitive to changes in ambient pressure. (D.L.C.)

459 (ORNL–3817) CERL-II. A COMPUTER PROGRAM FOR ANALYZING HEMISPHERE-NOZZLE SHELLS OF REVOLUTION WITH AXISYMMETRIC AND UNSYMMETRIC LOADINGS. Moore, S. E.; Witt, F. J. (Oak Ridge National Lab., Tenn.). Oct. 1965. Contract W-7405-eng-26. 47p. Dep. mn; CFSTI $3.00 cy, $0.50 mn.

CERL-II is a revised version of a computer code that calculates the stress distributions in a hemispherical pressure vessel with a radially attached nozzle. The nozzle may be entirely external or may also protrude into the vessel. The program calculates the stresses for any of four loadings: internal pressure, axial thrust on the nozzle, bending moment applied to the nozzle, and transverse thrust on the nozzle. Instructions are given for using the code. Input and output are described in detail and a Fortran listing of the code is included. Sample problems are also included that show the favorable comparison between experimental and analytical results. (auth)

460 (ORNL–P–1447) A NEW SIMILARITY PARAMETER FOR CORRELATION OF JET PUMP CAVITATION. LaVerne, Melvin E. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 7p. (CONF-651110–4). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From American Society of Mechanical Engineers, Annual Winter Meeting, Chicago.

The corresponding dimensionless groups obtained from a dimensional analysis of centrifugal and jet pump performance are compared. A new characteristic parameter for the correlation of jet pump cavitation performance is derived from the comparison, the new parameter being the analog of suction specific speed for a centrifugal pump. Data are presented to illustrate the correlating ability of the parameter. (auth)

461 (RFP–667) HYDROSTATIC BEARING EXPERIMENTS. Skulski, R. W. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Oct. 11, 1965. Contract AT(29-1)-1106. 4p. (CONF-651011–3). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From IMOG and Metrology Subgroup Meeting, Las Vegas, Nev.

Experiments were conducted on designing hydrostatic journal bearings for ultra-precision applications. Bending and unroundness were found to affect load deflection and runout, respectively. The design of hydrostatic bearings for this type of application is discussed. (D.L.C.)

462 (SC-DC–65-1554) RE-ENTRY OVERPRESSURE SHOCK SIMULATION TEST. Kampfe, William R. (Sandia Corp., Albuquerque, N. Mex.). Oct. 7, 1965. Contract AT(29-1)-789. 36p. (CONF-651016–2). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From 35th Symposium on Shock and Vibration, New Orleans.

At the Rocket Sled Track Test Facility, a test series simulating re-entry conditions during a possible overpressure blast was conducted on a large re-entry vehicle (RV). The dynamic blast simulation was achieved by impacting a propelled sled into a nonpropelled sled containing the instrumented RV. The impact amplitude and duration were controlled by having cutter bars on the propelled sled and shear-shaped metal attached to the nonpropelled sled. The impact forces were distributed around the RV and applied to its shell by phenolic microballoons which completely surrounded the re-entry shield surface. Before full-scale testing could begin, scale-model tests were necessary to develop the material shearing method and to select the proper material to surround the re-entry shield surface. This testing technique was developed on an 18-inch high g actuator. (auth)

463 (SC-DC–65-1634) A STUDY OF IMPACT EFFECTS ON SPHERICAL SHELLS. Quarterly Progress Report No. 6, February 1, 1965–April 30, 1965. Stoneking, Charles E. (Sandia Corp., Albuquerque, N. Mex.). Contract AT(29-1)-789. 12p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A research program is being conducted on the structural integrity of hollow spheres when they are impacted against rigid targets. Progress is reported on the theoretical analysis of cylinders, on the theoretical analysis of hollow spheres, and on the experimental part. (D.L.C.)

464 (TID–4100(Suppl.29)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Duthie, Richard E. C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Sept. 1965. 64p. Dep.; DTI Extension Free.

Lists are presented under the following headings: computers, hot laboratory equipment and structures, instruments, nuclear radiation instruments, nuclear reactors and reactor facilities, plant design and processes (chemical), radiation equipment (biological), and specifications. (D.L.C.)

465 THE COLLAPSE OF CYLINDER/SPHERE INTERSECTING PRESSURE VESSELS. Ellyin, F.; Sherbourne, A. N. (Univ. of Waterloo, Ontario). Nucl. Struct. Eng., 2: 169-80(1965).

A general method is presented for finding lower and upper bounds on the collapse pressure for a plastic-rigid vessel composed of intersecting cylindrical and spherical shells obeying Tresca's yield condition and associated flow rule. Depending upon the ratio (t/d)/(T/D) different types of solutions are generated. The solutions are presented in terms of generalized stresses and may be used in conjunction with any choice of yield surface of the form $\Phi(N_\varphi, N_\theta, M_\varphi) = C^2$. (auth)

466 STRESS DISTRIBUTION AT TWO NORMALLY INTERSECTING CYLINDRICAL SHELLS. Eringen, A C.; Suhubi, E. S. (Purdue Univ., Lafayette, Ind.). Nucl. Struct. Eng., 2: 253-70(1965).

The boundary value problem concerned with the state of stress in two normally intersecting circular cylindrical shells subjected to internal pressure is formulated. The differential equations of the two shells are solved for a small ratio of radii ($\rho_o/R < \frac{1}{3}$) subject to edge conditions along the intersection curve and at the ends of the cylinders. (auth)

467 STRESS ANALYSIS OF ROTATING DISKS. Cavallaro, L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Struct. Eng., 2: 271-81 (1965).

The equilibrium of a disk with variable thickness, symmetrical with respect to both its axis and its midplane, is analyzed, under the action of centrifugal and thermal loading. Introducing the customary assumption of plane stress, and neglecting the influence of shear stresses, the differential equilibrium equation is integrated, and stress analysis methods are derived. A digital computer program based on these methods is described briefly. Results of a typical numerical problem are presented. The method provides a very useful tool for the rapid investigation of the cost and performance of families of turbomachines for coolant circulation in gas-cooled power reactors. (auth)

468 ALUMINUM FOIL ULTRA-HIGH VACUUM GASKET SEAL. Batzer, Thomas H. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,478. Oct. 12, 1965.

A simple inexpensive, bakeable gasket seal for ultrahigh vacuum applications, for example 10^{-9} torr, utilizing a thin gasket of common household aluminum foil is described. The seal comprises a seat and flanged counter seat having planar annular surfaces, inclined at a slight angle with respect to the plane of closure and mating along their innermost circumferences. The vacuum seal is closed by inserting a thin aluminum foil gasket between the seat and counter seat and loading the flange along an outer circumference to compress the foil gasket between the mating annular seat and counter seat surfaces. (AEC)

Applications of Nuclear Explosions

Refer also to abstract 730.

469 (ORNL-TM-1275) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, July 1–September 30, 1965. Blake, C. A. Jr.; Brown, K. B.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Sept. 30, 1965. Contract W-7405-eng-26. 19p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Studies were continued on the possible behavior of radionuclides that would be present in copper recovery processes as a result of using nuclear explosives for breaking the ore. Measurement of the distribution of various radionuclides between acidic leach liquor and the ore solids showed the ion exchange capacity of the ore would be highly important in minimizing the amounts of certain radionuclides (Cs, Zr–Nb, etc.) taken into the leach liquor. In batch cementation tests significant fractions of the ruthenium and ^{95}Zr–Nb and of certain isotopes that could be formed by neutron activation cemented with the copper. In batch and column leaching tests, only very small amounts of radionuclides were dissolved from test shot debris under flowsheet leaching conditions. Of the fission products, ruthenium appeared to be the most troublesome with respect to contamination of the copper cementation concentrate. First measurements, obtained during shakedown testing of the experimental apparatus, have indicated no exchange of tritium and hydrogen between tritiated water and methane after the two gases had been mixed for 7 weeks at room temperature. The initial tritium concentration was 0.2 μC/ml. The U. S. Bureau of Mines at Laramie, Wyoming, and the oil shale plant at Rifle, Colorado, were visited to obtain chemical and engineering information pertinent to the possible application of nuclear devices to aid in the recovery of oil from shales. An experiment has been planned in which shale, artificially contaminated with radionuclides, can be first retorted, and then burned. The jet sampler system at Frankford Arsenal was modified to permit testing with larger specimens. Satisfactory focus, direction, and velocity of copper specimens was obtained. Gold and chromium targets, simulating elements more and less dense than uranium, will be jetted before the program is terminated in November 1965. (auth)

470 (PNE–1000) PROJECT GASBUGGY. (El Paso Natural Gas Co., Tex.; San Francisco Operations Office (AEC), Calif.; Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center; Bureau of Mines, Washington, D. C.; Lawrence Radiation Lab., Univ. of California, Berkeley). May 14, 1965. 61p. Dep. mn; CFSTI $1.00 cy, $0.75 mn.

A joint study was made of the feasibility of fracturing natural gas reservoirs with nuclear explosives, and an experiment was designed to test this concept. The beneficial effects of a nuclear explosion in a gas reservoir should be: 1. A network of fractures radiating out from the shot point that will permit more effective drainage of the reservoir; 2. An expanded wellbore that will allow higher sustained rates of production after initial drainage of the fractured zone; and 3. An effective storage volume for short-term high deliverability. The Pictured Cliffs formation, a gas reservoir in the San Juan Basin of northwestern New Mexico, was selected for analysis to determine if a field test in this area is feasible. This analysis resulted in the finding that nuclear-explosion stimulation of a Pictured Cliffs formation well at the proposed location may increase stabilized deliverability and gas recovery during the initial 20-year producing period by substantial factors over that obtainable by present completion methods. It is also concluded that an effective field test can be designed which would satisfy all safety requirements so that neither the possibility of radioactive contamination of the atmosphere or ground water nor the resulting ground shock would be a serious hazard. Furthermore, calculation of the level of radioactive contamination of the gas resulting from explosion of a fission device suggests that flaring some of the recoverable gas and employing other techniques could reduce the level of radioactivity to safe limits for transmission and ultimate consumption. Total cost of the experiment, exclusive of the cost of the explosive, is estimated at $3,000,000.00. (auth)

471 (PNE–1999) ISTHMIAN CANAL STUDIES, 1964. ANNEX III. CONSTRUCTION OF AN ISTHMIAN SEA LEVEL CANAL BY NUCLEAR METHODS, 1964. (Nevada Operations Office (AEC), Las Vegas; Army Engineer Nuclear Cratering Group, Livermore, Calif.; Panama Canal Co., Balboa Heights (Canal Zone)). Contract W-7405-eng-48. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A joint study was made of the cost, safety, and other factors involved in constructing a canal at two routes: Sasardi-Morti in the Darien Region of Panama and Atrato-Truando in northern Colombia. Developments made in the last four years are incorporated in the study together with

the scientific and engineering data on the two routes. The major problems which require further investigation are identified. (D.L.C.)

472 (PNE–2005) ISTHMIAN CANAL STUDIES, 1964. ANNEX III. APPENDIX 2. GENERAL CONSTRUCTION PLAN. (Panama Canal Co., Balboa Heights (Canal Zone)). Sept. 1964. Contract W-7405-eng-48. 77p. Dep. mn; CFSTI $1.00 cy, $0.75 mn.

A discussion is presented of the general construction required in the nuclear excavation of the canal on two proposed routes, Sasardi-Morti (Route 17) and Atrato-Truando (Route 25). The general nature and scope of the project are described, and the additional site information needed are given. The concept and general features of the conventional construction plan are given. Typical schedules and cost estimates are presented for the construction along each route. (D.L.C.)

473 (PNE–2006) ISTHMIAN CANAL STUDIES, 1964. ANNEX III. APPENDIX 2, INCLOSURE A. ON SITE SURVEY PROGRAM. (Panama Canal Co., Balboa Heights (Canal Zone)). Sept. 1964. Contract W-7405-eng-48. 25p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A description is given of an on-site survey program signed to obtain information for the study of the construction of a sea-level canal along Routes 17 and 25 by nuclear methods. Topography, geology, hydrography, meteorology, hydrology, seismic effects, population, ecology, economic resources, and camps are considered. Estimates of the cost of on-site surveys are included. (D.L.C.)

474 PLOWSHARE: SCIENTIFIC PROBLEMS. Werth, Glenn C. (Univ. of California, Livermore). pp 83-97 of State of Stress in the Earth's Crust. RAND Report R-428. New York, American Elsevier Publishing Co., Inc., 1964.

Plowshare, AEC's program on peaceful uses of nuclear explosions, is reviewed. Thermonuclear (fusion) explosions as a method of moving large masses of earth and rock are shown to be relatively inexpensive and also produce a low level of radioactivity as compared to fission reactions. Beginning in 1957 thirty-three underground nuclear tests were performed in tuff, alluvium, granite, and salt. During an underground explosion, vaporization and fusion of the rock adjacent to the shot chamber causes formation of a cavity. The extent of the cavity often is increased by the collapse of its roof; this collapse occasionally forms chimneys, particularly in alluvium. The temperatures drop as the shock wave proceeds outward. There is frequent satisfactory agreement between field measurements and theoretical conservation of energy equations and equations of state. Nuclear explosions have the following potential peaceful uses: economical block-caving methods in mining; advancement of seismology knowledge by study of the shock waves; and the economic excavation of large canals and highways. The related safety problems in such uses are being studied. (auth)

Facilities and Equipment

475 (AERE-M–1491) EQUIPMENT FOR THE MAINTENANCE OF HIGH-PURITY ATMOSPHERES IN GLOVE-BOXES. George, D. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 8p. Dep.; BIS $0.30; HMSO 1s. 9d.

An argon repurification plant capable of maintaining impurity levels at 10-20 parts per million by volume of water vapor and oxygen in a standard glove box is described in detail. (auth)

476 (LA-DC–7150) A NEW TECHNIQUE FOR REMOTE WEIGHING. McCloskey, M. W. Jr.; Wilson, M. T. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract W-7405-eng-36. 4p. (CONF-651101–4). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 13th Conference on Remote Systems Technology, Washington, D. C.

A balance beam extending through a cell shielding wall is being used to weigh irradiated samples from a few grams to several hundred grams, with 0.1-gram accuracy. The beam is mounted on a knife edge in a brass bar that plugs a cell access hole. The weight pan on the operating face is the standard pan of a Mettler Model K-7T balance. (D.L.C.)

477 (ORNL-P–1385) TWO-PIECE MANIPULATOR BOOT. Jenness, R. G. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 3p. (CONF-651101–5). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 13th Conference on Remote Systems Technology, Washington, D. C.

A two-piece manipulator boot was developed so that the lower section, including gauntlet, can be replaced remotely by another manipulator. Both sections are fabricated from nylon reinforced vinyl materials, and the support bands used are described. The installation of the lower section is described. (D.L.C.)

478 LOW ACTIVATION SHIELDING MATERIALS FOR NUCLEAR REACTOR ENVIRONMENTAL TEST CHAMBERS. Bingham, W. G. Jr. (Bechtel Corp., San Francisco/Los Angeles). Nucl. Struct. Eng., 2: 243-7(1965).

The results of a testing program and study to find low-activation shielding materials for nuclear reactor environmental test chambers are reported. Economic trade-offs associated with low-activation shielding materials are considered. Activation dose rates in existing test chambers are compared with study results. (auth)

479 APPARATUS FOR HEATING METALS TO HIGH TEMPERATURES. Navez, Emile; Demoulin, Camille (to Stein and Roubaix). U. S. Patent 2,197,184. July 27, 1965. Priority date Nov. 13, 1961, France.

An industrial furnace of conventional design is described that is capable of providing continuous oxidation-free metal heating up to temperatures of 1250 to 1300°C. The metal is heated to a high temperature by means of a direct flame resulting from the incomplete combustion of a gaseous fuel with combustive air. Both the gas and the air are heated continuously in a recovery system utilizing the heat of the neutral or oxidizing smoke issuing from the furnace. (B.L.M.)

Heat Transfer and Fluid Flow

See *also* PHYSICS — Fluid Physics and Thermodynamics

480 (AECL-2269) SHEATH TEMPERATURES. A G-20 COMPUTER PROGRAM FOR FUEL BUNDLES. Oldaker, I. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1965. 37p. Dep.; AECL $1.00.

The program calculates coolant and sheath temperatures in multi-rod bundles. Data of coolant properties, temperatures and flow rate together with reactor flux and bundle geometries are read in from cards. Output includes tables of hydraulic data followed by sheath temperatures at positions given in the input data. Corresponding coolant and differential temperatures in each subchannel are printed for the specified bundle heights. The fuel power calculated from the fuel parameters and flux pattern is used as a check on the accuracy of the calorimetric calculation. The program was used for trefoils, 7, 19, and 28-element bundles in organic, water and nitrogen. The accuracy of the results was checked for organics with two experiments, X-721 and U-301. In both cases the actual sheath temperatures measured with fin thermocouples agreed closely with predicted values. Details of the program and its calculations and complete instructions for using it on the G-20 are given. (auth)

481 (NAA-SR-Memo–11194) PRELIMINARY DESIGN OF MERCURY VAPOR SUPERSATURATION EXPERIMENT. Ostermier, B. J.; Ritchie, D. J. (Atomics International, Canoga Park, Calif.). June 21, 1965. Contract AT(11-1)-Gen-8. 41p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Preliminary studies of an experiment to allow investiga-

tion of the supersaturation of mercury vapor during rapid expansion have been made. The experiment will consist of a mercury flow system with an optical system for the detection of condensation droplets. Mercury will be boiled at 60 psia. The vapor will be passed through a separator-dryer to a rectangular cross-section nozzle, expanded through the nozzle, and condensed at approximately 1 psia. The nozzle will be equipped with windows such that a droplet detection device, employing the principle of light scattering, will scan the length of the diverging section. Brief discussions of nucleation-supersaturation and light scattering theory are presented. (auth)

482 (ORNL-P-1659) SUPERHEAT WITH BOILING ALKALI METALS. Edwards, J. A.; Hoffman, H. W. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 23p. (CONF-650946-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 4th High Temperature Liquid-Metal Heat Transfer Technology Conference, Argonne, Ill.

The results of experiments in a natural-circulation loop to establish the magnitude of the superheat associated with alkali-metal boiling are reported. For potassium boiling on an as-received (commercially smooth) surface, the superheat measured ranged from 500°F at a saturation temperature of 1500°F down to 230°F at T_{sat} = 1770°F. Wall-temperature oscillations, which occur in the presence of these large superheats because of the unusual thermal properties of the liquid metals, were of the order of 170 to 300°F at a frequency of 1.5 cycles/min. Because of maximum surface temperature limitations, sodium could not be boiled on this surface. Significant reductions in the magnitude of the superheat and, hence, in the amplitude of the wall temperature oscillations were effected by modifying the boiler surface. Thus, on a surface containing eight 0.006-in. diameter × 0.040-in.-deep cylindrical holes, the superheat with potassium was reduced about fortyfold below the value obtained on the as-received surface. A porous surface, formed by sintering of stainless steel particles on the inside tube surface, was less effective than the surface with discrete holes but still showed appreciable reductions in the superheat. Similar results were obtained with sodium. Over the limited range of these experiments, the superheat data for both potassium and sodium correlate reasonably with predictions based on a model involving a spherical vapor bubble in thermal equilibrium within a liquid pool of uniform temperature. (auth)

483 (TID-22224) PROGRESS REPORT [ON TWO-PHASE MOMENTUM FLUX AND DESIGN OF A HEAT PIPE], JUNE 30, 1965. Andeen, Gerry B.; Kern, Fred R.; Griffith, Peter (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3496. 42p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The momentum flux in upward two-phase flows through tubes is measured and analyzed, and models are studied. The calculations are presented in forms suitable for determinations of pressure drops in pipe flows. Fluctuations in momentum flux are studied. Excitation of physical oscillations by these fluctuations is discussed. The development of a heat pipe, and the factors governing the performance of such a pipe, are studied. The factor that limits heat transfer in water-filled wick-return heat pipes is found to be conduction through the wick at the cold end. For these heat pipes, it is found that very small amounts of non-condensable gases can cause dramatic reductions in the heat transfer performance of the heat pipe. (T.F.H.)

484 (TID-22282) BASIC STUDIES IN GAS-SOLID SUSPENSION. Quarterly Report No. 65-1, December 1964–February 1965. (Rutgers–The State Univ. of New Jersey, New Brunswick. Bureau of Engineering Research). Mar. 19, 1965. Contract AT(30-1)-2930. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The status of the research program on the fluid mechanics and heat transfer processes in gas–solid suspensions with turbulent flow is described. Modifications were made in the flow apparatus for heat transfer and cooling experiments, and the probes for temperature measurements are described. Progress on mass transfer experiments, density profiles, and particle drag coefficients is reported. Theoretical work was begun on particle motion in turbulent flow, particle-fluid interactions, and gas dynamics of suspensions. (D.L.C.)

485 (ANL-Trans-225) TEMPERATURE FIELDS IN A SUB-COOLED FLUID IN NUCLEATE BOILING. Latyshev, L. A. Translated by Elmar K. Wilip (Argonne National Lab., Ill.) from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn., 6: No. 4, 112-16(1963). 7p. Dep. mn; CFSTI $1.00 cy, $0.50 mn; JCL $1.10 fs, $0.80 mf.

The heat transfer in the boiling of a subcooled fluid is visualized as a heat flow in a continuous homogeneous medium with heat sinks of variable intensity. Bouguer's equation is used to derive the equation for the temperature distribution in the boundary layer: $\Delta t/\Delta t_0 = \exp(-4.6x/\delta)$, where x = distance from the heating surface, and δ = thickness of the boundary layer. A comparison of experimental and calculated curves gives excellent agreement, showing that the temperature in the boundary layer varies exponentially. The effects of different parameters on the turbulent heat conductivity are considered. (D.L.C.)

486 FLUID AND THERMAL TECHNOLOGY. Power Reactor Technol., 8: No. 3, 163-71(Summer 1965).

Reviews of the engineering properties of liquid metals are discussed along with data on forced-convection heat transfer and pressure drop for boiling K, data on the boiling-heat-transfer and burnout heat fluxes in boiling Na, and void fractions and flow rates of liquid metals in pipes. Reviews of information on two-phase flow and heat transfer are included. (J.R.D.)

487 EQUATIONS OF MOTION AND BOUNDARY CONDITIONS FOR VAPOR BUBBLE DYNAMICS. Plesset, Milton S. (California Inst. of Tech., Pasadena). 21p. (CONF-650557-4). Gmelin, AED-CONF-65-124-18.

From Conference on Boiling and Two Phase Flow for Heat Transfer Engineers, Berkeley/Los Angeles.

Some of the theoretical aspects of the growth and collapse of a vapor bubble in a liquid are considered. The quantitative formulation of the bubble dynamics problem is made by means of the equation of continuity, the force equation, and the energy equation for the liquid phase and for the vapor phase. These equations together with equations of state for both phases and boundary conditions determine in principle the solutions for the problem. It is not possible to solve the complete problem with the exact formulation, thus approximations must be made. The most useful approximation made is that the problem has spherical symmetry. The bubble growth and collapse problems are considered. (J.F.P.)

488 CRITICAL TWO-PHASE FLOW. Isbin, Herbert S. (Univ. of Minnesota, Minneapolis). 12p. (CONF-650557-3). Gmelin, AED-CONF-65-124-16.

From Conference on Boiling and Two Phase Flow for Heat Transfer Engineers, Berkeley/Los Angeles.

Investigations are singled out involving the determination of the design characteristics for maximum discharges of vapor-liquid systems. Maximum discharge rates for two-phase flow are known as choking or critical flows. The approach to the study of two-phase flow starts with the known single-phase critical flow phenomenon. Limits for the maximum discharges are established by considering the single-phase liquid discharge, and a homogeneous vapor-liquid mixture discharge. Several models are discussed. Empirical formulations noted are not discussed, inasmuch as the models, though differing in detail, represent surprisingly good agreement with experimental steam-water flow discharges from pipes and are presumed to be applicable over almost the entire range of flow conditions. (J.F.P.)

489 BUBBLE DYNAMICS IN BOILING. Bankoff, S. G. (Northwestern Univ., Evanston, Ill.). 16p. (CONF-650557-1). Gmelin, AED-CONF-65-124-15.

From Conference on Boiling and Two Phase Flow for Heat Transfer Engineers, Berkeley/Los Angeles.

Since a detailed understanding of the mechanics of boiling heat transfer must be preceded by an understanding of the mechanics of vapor bubble growth, some aspects of this progress are discussed, and general comments are made concerning future research areas. The simplest vapor bubble growth problem is the asymptotic growth of an isolated bubble originating in a liquid of initially uniform superheat. In the asymptotic growth stage the diffusion equation is uncoupled from the pressure equation, since inertial, surface tension, and viscous effects can be neglected in comparison to diffusional effects. The boundary conditions for the diffusion equation can, therefore, be obtained by assuming mechanical equilibrium between the bubble and its surroundings, and thermodynamic equilibrium between the vapor within the bubble and the liquid at the bubble wall. The exact and approximate solutions are considered for the asymptotic growth of an isolated bubble. (J.F.P.)

490 TRANSIENT HEAT TRANSFER TO LAMINAR BINGHAM-PLASTIC FLOW IN A CIRCULAR TUBE WITH INTERNAL ENERGY GENERATION. Henning, C. D.; Yang, W. J. (Univ. of Michigan, Ann Arbor). New York, American Inst. of Chemical Engineers, 1965, Preprint No. 35, 15p., $0.50. (CONF-650812-14). ORINS.

From ASME-AIChE Heat Transfer Conference and Exhibit, Los Angeles.

Investigations were made of transient heat transfer to a laminar-flowing Bingham plastic in a circular tube caused by timewise step and sinusoidal variations in the internal heat generation. Theoretical results were obtained for the temperature response of the fluid and wall by a numerical method. Experimental results were in good agreement with theoretical predictions. Heat exchangers to which these results apply include the homogeneous nuclear reactor and a chemical reactor in which a chemical reaction occurs. (M.C.G.)

491 A SYSTEMATIC CORRELATION FOR TWO-PHASE PRESSURE DROP. Baroczy, C. J. (Atomics International, Canoga Park, Calif.). New York, American Inst. of Chemical Engineers, 1965, Preprint No. 37, 35p., $0.50. (CONF-650812-15). ORINS.

From ASME-AIChE Heat Transfer Conference and Exhibit, Los Angeles.

It is shown that to describe adequately existing single and two-component, two-phase pressure drop data, it is necessary to include, on a continuous basis, the simultaneous influences of pressure and mass velocity in addition to those of the respective fluid flow rates. A correlation is presented, which accomplishes this by showing the two-phase multiplier to be a function of liquid to gas viscosity and density ratios, mass velocity, and mixture quality for both single and two-component fluids. The correlation devised provides two separate sets of curves: a plot of the two-phase multiplier as a function of the property index, with quality as a parameter for a mass velocity of 1×10^6 lb/hr-ft^2, and plots of the two-phase multiplier ratio as a function of the property index and quality for mass velocities of 0.25, 0.50, 2, and 3×10^6 lb/hr-ft^2. (M.C.G.)

492 INFLUENCE OF AXIALLY NON-UNIFORM HEAT FLUX ON DNB. Tong, L. S.; Currin, H. B.; Larsen, P. S.; Smith, O. G. (Westinghouse Electric Corp., Pittsburgh). New York, American Inst. of Chemical Engineers, 1965, Preprint No. 17, 11p., $0.50. (CONF-650812-12). ORINS.

From ASME-AIChE Heat Transfer Conference and Exhibit, Los Angeles.

The memory effect on DNB (departure from nucleate boiling) is discussed. A correction factor was developed to account for the effect of flux nonuniformity. Predicted equivalent DNB fluxes for various shapes of nonuniform heat flux distributions were compared with corresponding uniform flux DNB data. (M.C.G.)

Materials Testing

Refer also to abstracts 667, 1366, and 1533.

493 FILM THICKNESS MEASUREMENT BY X-RAY EMISSION AND BETA RAY BACKSCATTER TECHNIQUES. Basl, G. J.; Soffa, L. L. (North American Aviation, Inc., Canoga Park, Calif.). Mater. Evaluation, 23: 493-5(Oct. 1965).

Film thickness measurements were made on printed circuit board material plated with gold over copper. Nondestructive test methods investigated consisted of x-ray emission, absorption techniques, and beta backscatter test methods. X-ray methods were found to be accurate and easily reproducible. Optical examination of the specimens indicated that the plating thickness is 10 to 30 per cent thicker than found by beta test methods. Extreme inconsistencies of thickness measurement were found by beta test methods. (auth)

494 PROFILOMETER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1183).

6 drawings.

The profilometer described was designed for use in a physical-examination hot cell. It is used specifically for examination of fuel tubes of the PM-1 Army Reactors, but with small modifications would be useful for other physical examination work. (For Details, See TID-4100) (M.C.G.)

Protective Structures

Refer also to abstracts 1307, 1308, and 1310.

495 ROCK MECHANICS CONSIDERATIONS IN THE DESIGN OF UNDERGROUND PROTECTIVE STRUCTURES. Brode, Harold L. (RAND Corp., Santa Monica, Calif.). pp 653-64 of State of Stress in the Earth's Crust. RAND Report R-428. New York, American Elsevier Publishing Co., Inc., 1964.

The phenomena and effects accompanying nuclear explosions on or in hard rock were examined in relation to the possible response of underground openings. The possibilities for both resistant and isolating linings were explored in order to examine the adequacy of underground protective structures. (auth)

496 NUCLEAR SURFACE BURSTS AND THE DESIGN OF PROTECTIVE CONSTRUCTION IN HARD ROCK. Bergman, Sten G. A. (Royal Swedish Fortification Administration, Stockholm). pp 667-77 of State of Stress in the Earth's Crust. RAND Report R-428. New York, American Elsevier Publishing Co., Inc., 1964.

The effects of nuclear bursts on hard rock ground are considered with regard to protective tunnel design. The rock half-space is divided into five zones, for which various design requirements have to be considered. Results from TNT tests on granite models are reported, especially for spalling effects. The large displacements in the rock seem to necessitate spring-mounted buildings in protected tunnels far from the explosion. (auth)

Space Propulsion

See also **ISOTOPE TECHNOLOGY — Power Application**
REACTOR TECHNOLOGY — Propulsion and Space

497 (AD-612175) ELECTRON CYCLOTRON RESONANCE PLASMA ACCELERATOR. Final Technical Report, January 1–December 31, 1964. Hendel, H.; Faith, T. (Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.). Jan. 31, 1965. Contract AF49(638)-1342. 33p. CFSTI $2.00 cy, $0.50 mn.

Results are presented for a continuously operating electron cyclotron reasonance plasma accelerator at a frequency of 2.45 kMc and absorbed power levels of up to 0.5 kilowatt. Langmuir probe measurements indicate that a space charge field set up by energetic electrons (electron temperature approximately 15 electron-volts) accelerates

plasma ions to energies of from 35 to 150 ev. Langmuir probe plasma potential measurements were made adjacent to the analyzer and the effects of ion acceleration in the plasma beam-analyzer sheath were subtracted from the ion energy measurements. The final ion energy shows a linear relationship to the electron temperature in agreement with the theory. At a power of 0.5 kilowatt, due apparently to strong excitation in the magnetic bottle region, electrons from this region are connected by the magnetic field lines to the waveguide walls and losses for bottle configurations of the magnetic field were found to be high (efficiency of 4%). Constant-magnetic-field experiments indicate that efficiencies with magnetic bottle field should be at least as high as 30% if the accelerator is designed to exclude all field-line connections between wall and plasma. The specific impulse, efficiency, and thrust attainable from a thruster based on electron cyclotron resonance are in the useful range for space propulsion applications, especially in orbit corrective missions. (auth)

498 (NASA-CR-54136) ION ROCKET ENGINE DEVELOPMENT. (Hughes Research Labs., Malibu, Calif.). Aug. 1965. Contract NAS 3-4109. 294p.

The development is outlined of a cesium contact ion rocket engine exhibiting a thrust of 15 mlb at a specific impulse between 6000 and 9000 sec, and of such a configuration that it can be used as the basis for higher thrust engines by clustering. The design and fabrication of the development engines, the development and life tests of the engines, and the performance and life-limiting problems are studied. The engine design developed is a multiple-strip "cold" focus electrode type. Solutions to the problem of charge-exchange erosion are suggested. Analysis of the ionizer heater design indicates a calculated life time of this element of 50 years, which greatly exceeds any expected mission duration. An electrode temperature of 800 to 900°K prevents the current drains from increasing without limit as a function of test time. Thermal analysis provides data for an engine design that can ensure operation of the electrodes at the desired temperature, as well as operation of the focus electrode at a temperature low enough to prevent ion formation at its surface. (auth)

499 (NP-15541) THE EFFECT OF COHERENT RADIATION ON THE STABILITY OF A CROSSED-FIELD ELECTRON BEAM. Research Report No. 213. Levy, R. H. (Avco-Everett Research Lab., Everett, Mass.). June 1965. Contract NASw-1101. 51p.

A toroidal space vehicle might be raised to a very high positive potential relative to the surrounding space by causing a stable crossed-field electron beam to circulate around its outer surface. In this arrangement the electric field exists only between the space vehicle and the electron beam; the magnetic field is imposed by coils within the space vehicle. Such a beam can be stabilized against the diocotron (slipping stream) instability by being made sufficiently thick. The stability against coherent radiative perturbations of such a thick beam is studied under the following simplifying assumptions: the geometry is taken as infinite cylindrical; the ratio of all frequencies in the problem to the electron cyclotron frequency is negligible; no perturbation electric fields exist along the magnetic field lines; on the basis of an analogy, but without direct proof, certain continuous spectra of real eigenvalues occurring in the problem are unimportant; the electrons are cold; and the outer boundary of the "space vehicle", i.e., the cylinder, is perfectly conducting. It is concluded that if there is a gap between the inner edge of the beam and the cylinder, one unstable mode is present for each azimuthal mode number $l \geq 1$. (auth)

500 EXPERIMENTAL PERFORMANCE OF A HIGH SPECIFIC IMPULSE ARC JET ENGINE. John, R. R.; Bennett, S.; Connors, J. F. (Avco Corp., Wilmington, Mass.). Astronaut. Acta, 11: 97-103(Mar.-Apr. 1965).

A liquid-cooled arc-jet engine was operated over the power range from 75 to 200 kw and at specific impulses (I_{sp}) up to 10,000 sec using hydrogen as a propellant. Overall energy conversion efficiency defined as the ratio of thrust power to electric input power increases with I_{sp} and reaches a value close to 50% at 10,000 sec. Since the measured thrust is not directly proportional to the product of chamber pressure and throat area, it is concluded that the measured thrust is not completely aerodynamic in nature. It can be correlated with current, cathode tip and chamber pressure on the basis of mechanisms proposed by Maecker to explain the cathode jet characteristic of the high-current carbon arc. Comparison of the present experimental results with those reported for the thermo-ionic accelerator strongly suggest that the thrust-producing mechanisms in both devices are the same. The dominant energy loss mechanism (for $2,500 < I_s < 7,500$ sec) appears to be that associated with frozen flow, which should be reducible by utilizing heavier molecular weight propellants. (auth)

501 MEASUREMENT OF VELOCITY OF PLASMA IN THE PLASMOTRON NOZZLE AND IN THE FREE STREAM OF PLASMA. Jedrzejec, H.; Suckewer, S. Nukleonika, 10: 195-200(1965). (In Russian).

A method for the measurement of plasma velocity inside the plasmatron nozzle as well as for measurement of plasma velocity from the combustion chamber is described. The method is based on the optical observations of the ion cloud produced in the plasma by the electric discharge. The results of velocity measurements as a function of mass of flow of the stabilizing gas in the plasmatron and of flow of the fuel in the combustion chamber are given. (auth)

502 LIQUID-PROTECTED ELECTRODES. Moore, David (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint No. 65-378, 25p., $1.00. (CONF-650711-14). ORINS.

From AIAA 2nd Annual Meeting and Technical Demonstration, San Francisco.

A liquid-metal alloy was developed, which gives a protected tungsten substrate a lifetime over 15 times that of an identical unprotected tungsten substrate in ion propulsion engines. The substrates were exposed to high-intensity beams of 4-kv cesium ions, while the test liquid had to wick up the substrate to over an inch above the free liquid surface. The electron emission currents from a liquid-protected accelerator electrode were less than 10% of that of the same accelerator without the liquid. (M.C.G.)

503 DEVICE FOR THE GENERATION OF A PLASMA JET. Koller, Alois (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,200,447. Sept. 9, 1965. Filed Mar. 5, 1964.

The device for the generation of a plasma jet especially suited for the propulsion of space ships comprises a Z-pinch arrangement with an opening through which the compressed hot plasma is expelled. A theta-pinch arrangement acting upon the discharge volume of the Z-pinch arrangement is provided the operation of which is periodically alternated with the operation of the Z-pinch arrangement. (Gmelin Inst.)

Vacuum Engineering

Refer also to abstract 915.

504 (ORNL-3836, pp 120-9) DESIGN AND ENGINEERING—NOTES. (Oak Ridge National Lab., Tenn.).

A discussion is given of a program to develop encapsulated electromagnets, including the ability to operate these magnets directly in a vacuum system at 10^{-7} torr base pressure. Another aspect of electromagnet technology described is a method for brazing consistently good connectors which serve as both electrical and cooling-water terminals without damaging nearby electrical insulation. A description is included of the fabrication procedure for making a particularly difficult aluminum corona shield, which is an example of the kinds of metal fabrication problems encountered. Progress in the development of small-diameter, high-temperature electrostatic probes is reported. Differential vacuum-system liners capable of

high-temperature bakeout and subsequent cryogenic-temperature cooling have been the source of leaks in ultra-high vacuum systems due to corrosion problems. An approach to alleviating this problem is described. (auth)

505 (ORNL-P-1517) A NEW, VERSATILE VACUUM QUICK-SEAL AND VACUUM LOCK. Matlock, O. D. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 8p. (CONF-650512-15). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Livermore, Calif.

An all-metal quick seal was developed for work with microwaves. The method and sequence of assembly are described. A "quick valve" comprising a compact integral valve, lock, and pump out system is also described, along with details of its assembly to a quick seal with a wire probe. (D.L.C.)

506 RESIDUAL-GAS ANALYSIS OF A DC-705 OIL-DIFFUSION-PUMPED UHV SYSTEM. Gosselin, Charles M.; Bryant, Paul J. (Midwest Research Inst., Kansas City, Mo.). J. Vacuum Sci. Technol., 2: 293-7 (Nov.-Dec. 1965).

The residual gases present in a DC-705 oil-diffusion-pump uhv system were determined as a function of various trapping conditions. The system was equipped with a metal 2-in. oil-diffusion pump in series with a specially designed trap in which zeolite was used. The configuration of the trap permitted the trapping zone to be immersed in cryogenic liquids. The effectiveness of the trap was determined as a function of temperature. A comparison of the residual gases was made for six conditions, including three trapping temperatures, while operating with zeolite and without zeolite. (auth)

507 DIFFUSION-SORPTION PUMPING. Read, P. L.; Glascock, H. H. Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Vacuum Sci. Technol., 2: 307-8(Nov.-Dec. 1965).

An evacuation technique is described, which utilizes the selective diffusion of a gas through a semipermeable membrane combined with the persorption of gases by a chilled sorbant. The pressure in a small system was reduced from 760 to 1×10^{-8} Torr by using the diffusion of hydrogen through a palladium-25% silver foil combined with the sorption of gas on liquid-nitrogen-chilled synthetic zeolite. The diffusion-sorption technique was found to be especially suitable for use as a forepump in getter-ion-pumped ultra-high-vacuum systems, since it allows the ion pump to be started at quite low pressures. (M.C.G.)

508 PRACTICAL VACUUM TECHNIQUES. Brunner, W. F. Jr.; Batzer, T. H. New York, Reinhold Publishing Corp., 1965. 198p. $8.25.

This book treats vacuum technology at the technician level. After a consideration of the theory of gases and the kinetics of flow, the operating principles of gases, pumps, baffles, valves, and leak detectors are described. Maintenance, repair, and symptomatic trouble-shooting are covered. Tabular information essential to the operation and maintenance of vacuum systems are included as appendices. (D.L.C.)

509 CARBON-COATED ELECTRON-TRANSMISSION WINDOW. Hester, Ross E.; Sherwood, William A. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,947. Oct. 12, 1965.

A foil window whereby a high-energy electron beam of the order of 200 amperes at 5 Mev may be transmitted from a high vacuum region to a region of higher pressure is described. The invention comprises a thin, aluminum oxide foil disc of the order of 3 cm in diameter, together with a carbon coating approximately 200 angstroms in thickness adhered to one side of the aluminum oxide foil. (AEC)

GEOLOGY, METEOROLOGY, AND MINERALOGY

General

510 (EUR–2167.d) ENTWICKLUNG UND UNTERSUCHUNG EINES RADIOAKTIVEN INDIKATORVERFAHRENS ZUR MESSUNG DER KINETIK, DER EROSION UND DES SANDTRANSPORTES AN SANDIGEN GRANDUNGSKUESTEN. (Development and Testing of Radioactive Tracer Method for Measuring the Kinetics of Erosion and Sand Displacement Caused by Surf). Dolezal, R.; Petersen, M.; Becker, H.; Goette, H.; Schulze-Pillot, G.; Tomschke, E.; Boettcher, B.; Nachtigall, K. H.; Seibold, E. (European Atomic Energy Community). 1965. 156p. Dep. mn.

A series of 10 studies in the development and testing of the radioactive tracer method for measuring the kinetics of erosion and sand displacement are compiled. The importance of radioactive-labeled sand for water economy studies is indicated. Previous investigations on sand erosion using radioactive indicators are summarized. The methods for the surface labeling of natural sand with radioisotopes are investigated. The development of a sand vessel with its shielding devices and carrier for the transport of active sea sand is described. The precautions to be taken in the use of radioisotopes are emphasized. The sand erosion in the surf was measured with ^{46}Sc on the North Sea and the Baltic Sea. Results obtained with phosphors were also reported. The complete method developed through these individual studies is then reported. (J.S.R.)

511 (PNE–505P) PRESHOT INVESTIGATIONS FOR PROJECT PRE-SCHOONER, BUCKBOARD MESA, NEVADA TEST SITE. Project Pre-SCHOONER. Nugent, R. C.; Banks, D. C. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Sept. 1965. 144p. Dep. mn; CFSTI $1.00 cy, $1.00 mn.

A preshot geologic and engineering investigation was conducted at the four sites selected for Project Pre-Schooner, a series of chemical explosions in dry basalt. The results reported include: subsurface conditions, joint patterns, joint frequency curves, and engineering properties of basalt (compressive strength, angles of internal friction, cohesion, dynamic tensile strength, bulk specific gravity, modulus of elasticity, Poisson's ratio, etc.). (D.L.C.)

512 $^{234}U/^{238}U$ IN SEAWATER FROM THE KUROSHIO REGION. Umemoto, Shunji (Okayama Univ., Misasa, Japan). J. Geophys. Res., 70: 5326-7(Oct. 15, 1965).

Samples of seawater were obtained from two different points of Sagami Bay at a depth of about 20 m. The $^{234}U/^{238}U$ ratios in the samples were determined as well as the U contents. (D.C.W.)

513 STATE OF STRESS IN THE EARTH'S CRUST. Proceedings of the International Conference, June 13 and 14, 1963, Santa Monica, California. Judd, William R. (ed.). RAND Report R-428. New York, American Elsevier Publishing Co., Inc., 1964. 738p. (CONF-630602).

Proceedings of the International Conference on the State of Stress in the Earth's Crust are presented. The scope of the conference, fundamental theories on stresses in rocks, theories and instruments used to obtain quantitative measurements of stress conditions in the crust, and applications of these theories and measurement methods are discussed. Separate abstracts were prepared for 3 of the 20 papers. (M.C.G.)

For abstracts of individual papers see: 474, 495, and 496.

Meteorology

See also Site Survey and Selection

514 (CONF–650407, pp 429-38) A METHOD OF RAPID DETERMINATION OF ATMOSPHERIC DIFFUSION PARAMETERS. Asculai, E. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev).

The following method facilitates the rapid evaluation of the diffusion parameters. The main source parameters needed for the diffusion estimates are the mean wind direction $\bar{\theta}$, the mean wind speed $\bar{u}$, and the two standard deviations σ_y and σ_z representing the lateral and vertical dispersions. These last two parameters are given as the product of x[or f(x)] and the standard deviation of the wind direction (σ_θ) or inclination (σ_ϕ) with averaging times S and measured over the whole sampling period τ. S is a function of the downwind distance and of the mean wind speed. τ is either the period of release or the relevant time of exposure. The measuring system incorporated in this method may measure the mean wind direction, σ_θ and/or σ_ϕ and may be utilized at various S and τ values. The measuring system utilizes relatively a high-frequency sampling of the varying parameter (θ). This is done by the "chopping" of a varying d-c signal at a high rate and feeding the resultant pulses (after amplification) into a multichannel analyzer. Periodic or total results may be taken from the instrument, according to the desired τ or S, which may vary over a wide range. The usual output is made through a digital printer, and the results may then be quickly evaluated without great error. A mean direction corresponding to the peak value (usually found at the axis of symmetry) may be obtained quite accurately because of the good resolution of the system. Instead of using the cumbersome calculations for the determination of the standard deviation, the width (the distance between 0.1 of the axial or peak values) is utilized. The agreement between the observed and calculated values of σ_θ (taken as 0.23 times the width of trace) is found to be quite good and not to depend greatly upon the position of the peak value (some asymmetry and deviation from a normal curve will not cause a sensible error). By the use of graphs for the evaluation, the value of σ_ϕ for the proper averaging and sampling time is obtained. These are utilized either according to predetermined classifications or directly in the equations of diffusion. The mean wind speed is determined from a wind run (integrator) recorder. The operation of the system is easy, and the evaluation of the results is very quickly done. This system is also utilized to measure at the same time two variables (θ and ϕ) and study the shape of the variation. Some other utilizations of the system include climatological, "gradient," and flow-around-obstruction studies; some of the results are discussed. (auth)

515 (RT/PROT(65)17) DETERMINAZIONE DELLA STABILITA DELL'ARIA SECONDO I CRITERI DI PASQUILL PER LE STAZIONI ITALIANE. (Determination of Air Stability According to Pasquill's Criteria for Italian Stations). Giudici, G.; Mingrone, P.; Rosini, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1963. 8p. (CONF-631110–1). Dep. mn.

From 12th Meeting of the Italian Geophysics Association, Rome.

When a site has to be selected for the installation and operation of a nuclear reactor, the condition of air stability or instability in the first atmospheric layer must be taken into account, in relation to diffusion of radioactive effluents introduced into the air during normal operation or from an accident. After explaining Pasquill's criteria for determining the stability degree as a climatic characteristic, an application of such criteria to the Italian meteorological stations, using the observations of a five-year period, is shown. The determination of the stability category is made by means of an electronic computer, functioning as a logical selector. A few examples are then illustrated, and considerations are made on the results obtained. (auth)

516 (TID–22278) A CONSTANT TEMPERATURE WIND COMPONENT METER DEVELOPMENT AND APPLI-

CATION. Final Report. Miyake, Mikio (Washington Univ., Seattle. Dept. of Atmospheric Sciences). June 1965. Contract AT(45-1)-1545. 125p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

A constant-temperature-difference hot thermocouple wire anemometer was developed as an improved model of an existing component meter. The constant-temperature-difference mode of sensing eliminates the need for correction of the effect of temperature in total wind sensing, and the effect of wind in angle sensing. This feature also provides high sensitivity even in high wind. The new model incorporates a fast-response temperature measurement circuit. Thus the instrument is capable of determining the flux of heat as well as that of momentum. The analysis of performance established the response of the wind-measuring system to be that of a second-order system. A setting of amplifier gain which makes damping ratio 0.7 and natural frequency 2.5 cps gives undistorted frequency and phase response up to 1 cps. Above this frequency, distortion is specified by a known transfer function. This was confirmed by a wind tunnel test. The response of the temperature-sensing circuit can be described by a transfer function of the first order in which a time constant specifies complete characteristics. In the model used in this study the time constant was 0.115 seconds. Performance of the wind meter in the field was compared with that of a Beckman anemometer and wind vane, and with a sonic anemometer-thermometer. The comparison included examination of simultaneous analog signals in the time domain from different sensors, and examination of spectra functions computed for the frequency range of 0.003 cps to 5 cps under four different meteorological conditions. The result of the field experiment confirmed the analysis of the performance characteristics. It is concluded that the wind meter is capable of determining the flux of heat and momentum near the surface. (auth)

517 (UCRL-12415-T) CONVECTION IN A SIX-LEVEL MODEL ATMOSPHERE. Leith, C. E. (Lawrence Radiation Lab., Univ. of California, Livermore). June 1965. Contract W-7405-eng-48. 11p. (CONF-650656-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Dynamics of Large-Scale Processes in the Atmosphere, Moscow.

Calculations using the tropical atmosphere as a test region led in several tentative convection laws. These laws give water vapor and cloud cover distributions which are in agreement with observations. A terrestrial radiation transport calculation of the cooling of the atmosphere was also made. (D.L.C.)

518 EIGHTH AEC AIR-CLEANING CONFERENCE. Adams, R. E. Nucl. Safety, 5: No. 3, 250-4 (Spring 1964).

Information based on a review of conference papers is presented on filtration of micron and submicron particles, applications of air-cleaning technology, particle and gas releases and their behavior, radioiodine behavior, containment of radioactivity, atmospheric monitoring, and gas cleaning problems. (J.R.D.)

519 1964 HURRICANE TRITIUM. Ostlund, H. Gote (Univ. of Miami, Florida). 6p. (CONF-650652-5). Gmelin, AED-CONF-65-158-16.

From International ^{14}C and ^{3}H Dating Conference, Pullman, Wash.

Preliminary attempts to collect liquid water and water vapor for tritium assay were made during the 1964 hurricane season. Results are reported from tritium analyses of rain collected at ground level from 3 hurricanes and at altitudes of 2000 and 5000 ft from one hurricane. Results indicate that hurricane rains have lower tritium contents than normal rains of the area. It is postulated that data on tritium content of rain water could be used to determine the energy input of hurricanes and the mixing ratio of stratospheric to tropospheric air at different altitudes in the eye could be determined quantitatively from measurements of T-atoms/kg of air. (C.H.)

Natural Radioactivity and Fallout

See also HEALTH AND SAFETY

Refer also to abstracts 90, 596, and 597.

520 (CEX-59.4(Pt.3)) AERIAL RADIOLOGICAL MONITORING SYSTEM. PART III. ELECTRONIC PROCESSING OF ARMS-II DATA. Hand, J. E.; Borella, H. M. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Dec. 1962. Contract AT(29-1)-1183. 70p. (S-224-R). Dep. mn; CFSTI $1.00 cy, $0.75 mn.

A method of utilizing electronic data-processing techniques for th reduction and presentation of airborne terrestrial-radiation measurements is presented. Systematic surveys of terrestrial radiation occurring over large land areas are performed throughout the United States. A nominal-sized area entails some 10,000 traverse miles of flying with the acquisition of nearly 100,000 data points. As a consequence, manual reduction and presentation of the raw data are highly impractical. For rapid reduction and early availability of the data, it is necessary that modern electronic techniques be adapted to the processing of ARMS-II data. The system described utilizes the IBM-704 electronic computer as the principal processing machine. Peripheral gear includes the following IBM equipment: 1401 computer, 407 lister, 047 tape-to-card converter, 523 summary punch, and 082 card sorter. An Electronics Associates, Inc., model 3200 Dataplotter with a 30- by 30-in. plotting surface is employed to present the finished data graphically. Data are recorded in flight as binary entries onto punched tape. The data on the field tapes and the ground measurements necessary for computation are sent to the ARMS-II laboratory and converted to IBM card formats for entry into the computer. The data are taken to the computer center and processed; the computer provides the output information as a decimal tabulation of the radiation levels and their associated geocentric coordinates and converts the data to coordinates that are compatible with the X-Y plotter input requirements. The data positions and radiation levels are plotted as map overlays at 1 mile per inch scale, from which the final presentation form is prepared. The position data are accurate to 0.001°, with ±9% uncertainty present in the radiation levels. (auth)

521 (HASL-164) HEALTH AND SAFETY LABORATORY FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, JUNE 1, 1965-SEPTEMBER 1, 1965. Hardy, Edward P. Jr.; Rivera, Joseph (Health and Safety Lab., New York Operations Office (AEC), N. Y.). Oct. 1, 1965. 332p. Dep. mn; CFSTI $7.00 cy, $1.50 mn.

Current data from the Health and Safety Laboratory Fallout Program, the National Radiation Laboratory in New Zealand, and Argonne National Laboratory are presented. Radionuclide levels in monthly fallout, milk, tap water, diet, and upper air samples are tabulated. Also included are interpretive reports and notes dealing with fission yield and fission product decay, a material balance of strontium-90, plutonium-238 from SNAP-9A, the half-time of cesium-137 in man, cesium-137 in man and his diet, and strontium-90 in infant diets. A bibliography of recent literature pertinent to nuclear debris studies is given at the end of the report. (auth)

522 INVESTIGATION OF RADIOACTIVITY IN PLZEN. Matousek, J.; Mertl, F.; Patocka, S. (Charles Univ., Plzen, Czechoslovakia). Acta Univ. Carolinae Med., Suppl. 20, 84-5 (1964).

Since 1957, the level of total long-term artificial β radioactivity of atmospheric aerosols has been followed at this Institute in Plzen; the radioactivity of rainfall has been measured since July 1959, and radioactive fallout since 1960. Measurements of the air radioactivity were performed daily, those of radioactive fallout at weekly and monthly intervals. The activity of rainfall was measured continuously. Results are given and correlated with atmospheric nuclear tests prior to 1959. (TCO)

523 METEOROLOGICAL IMPLICATIONS OF MEASUREMENTS OF ^{90}Sr IN AUSTRALIA. Gibbs, W. J.; Wilson, G. U. (Bureau of Meteorology, Melbourne). Australian J. Sci., 28: 59-69(Aug. 1965).

Most of the ^{90}Sr found in the Australian environment was deposited in rainfall and was originally injected into the stratosphere in the northern hemisphere during nuclear weapons tests. Current knowledge of air motion in the stratosphere is reviewed and meteorological factors affecting the dispersal of fallout materials in both hemispheres and its gradual transfer into the troposphere and deposition over Australia are discussed. (C.H.)

524 RADIOACTIVITY MEASUREMENTS IN FOODSTUFFS. II. FALLOUT-CONDITIONED CONTAMINATION OF MILK IN BADEN-WUERTTEMBERG IN SPRING, 1964. Jaegerhuber, P.; Bergner, K. G.; Kruse, C. L. (Chemische Landesuntersuchungsanstalt, Stuttgart). Deut. Lebensm. Rundschau, 60: 340-3(Nov. 1964). (In German).

In the spring of 1964 milk samples were obtained from 62 large dairies scattered throughout W. Germany. The dairies selected produce 70% of the milk consumed in the nation. Concentrations of ^{131}I, ^{137}Cs, ^{89}Sr, ^{90}Sr, and nonradioactive Ca and K were measured in the samples. The average value of K was 1.53 g/l, with a range from 1.23 to 1.81 g/l. The average value of Ca was 1.15 g/l, with a range from 1.09 to 1.27 g/l. The average concentration of ^{90}Sr was 42 pC/l, with a range from 13 to 124 pC/l. These values resulted in an average of 36 pC/g Ca, with a range of 11 to 102 pC/g Ca. The average concentration of ^{137}Cs was 227 pC/l, with a range from 72 to 1252 pC/l. The average value of pC/g K was 153, with a range from 49 to 824 pC/g K. In the Badin-Wuerttemberg area it was estimated that 1,818,700 persons were exposed to milk with a ^{90}Sr range of less than 25 pC/l, 5,572,000 were exposed to from 25 to 50 pC/l, 742,900 were exposed to 50 to 100 pC/l, and 24,100 were exposed to more than 100 pC of ^{90}Sr/l. In this area 6,414,100 persons were exposed to milk with a ^{137}Cs range of less than 200 pC/l, 1,561,100 were exposed to from 200 to 400 pC/l, 20,100 were exposed to from 400 to 800 pC/l, and 162,500 persons were exposed to more than 800 pC of ^{137}Cs/l. The direct estimation of ^{90}Sr activity is much more accurate than its evaluation from the widely varying ratio between pC of ^{137}Cs/g K and pC ^{90}Sr/g Ca. Studies of this ratio indicate that it may vary within a range from 1.6 to 10, with an average value of 3.9. This represents a variance of ±38%. (BBB)

525 GAMMA-EMITTING RADIONUCLIDES IN ALASKAN TUNDRA VEGETATION 1959, 1960, 1961. Rickard, W. H.; Davis, J. J.; Hanson, W. C.; Watson, D. G. (General Electric Co., Richland, Wash.). Ecology, 46: 352-6(1965).

Radioassays of six fallout radionuclides were made on a wide variety of seed plants, mosses, and lichens collected in the Ogotoruk Valley of northwestern Alaska. Vegetation samples were collected during the years of nuclear test ban (1959-61). As expected, the radioactivity of plant samples declined in the absence of nuclear testing, which is attributed to the decay of the short-lived radionuclides. Cerium-144 was the most abundant radionuclide measured, but the long-lived radionuclide, ^{137}Cs, contributed more to total radioactivity in 1961 than it did in previous years. Smaller amounts of $^{106}Ru-^{106}Rh$, $^{95}Zr-^{95}Nb$, ^{54}Mn, and ^{65}Zn were also measured. Lichens and mosses contained more radioactivity than terrestrial vascular plants. Foliar interception appeared to be an important means of fallout accumulation. Terrestrial plants with persistent above-ground parts accumulated more ^{137}Cs than plants with more ephemeral above-ground parts. The lowest ^{137}Cs values were associated with aquatic emergent plants having aerially exposed parts for the shortest periods of time. Although the persistence of above-ground parts appears as the primary means of fallout accumulation by vegetation, the accumulation and deposition of radionuclides by drifting snow may also be an important factor. Lichens collected from a snow-free ridge crest and snow bank area showed differences in radionuclide content, especially ^{137}Cs. The mechanism of fallout accumulation appears to be a concentration of detritus and fallout by shrinking snow banks with a subsequent filtering of melt waters by vegetation. With the sudden resumption of nuclear testing in the Eurasian Arctic in early September 1961, by late September prompt increases in total radioactivity were seen. At this sampling ^{95}Zr increased tenfold; ^{144}Ce and ^{106}Ru increased more than two-fold. The amount of ^{137}Cs, however, showed little change. (BBB)

526 ^{90}Sr IN UPPER LAYERS OF COASTAL SEDIMENTS OF THE LIGURIAN SEA AND CONTRIBUTION OF SOME RADIONUCLIDES TO THEIR RADIOACTIVITY. Cerrai, E. (Laboratori CISE, Milan); Schreiber, B.; Triulzi, C. Energia Nucl. (Milan), 12: 549-52(Oct. 1965).

The content of ^{90}Sr was determined in samples of upper layers of coastal sediments by using the first five portions of three cores collected at a bottom depth of either 85 or 120 m. The presence of ^{90}Sr was detected in the first three portions, which corresponded to a 6-cm thick layer. The contribution of $^{90}Sr + {}^{90}Y$, $^{144}Ce + {}^{144}Pr$ and ^{147}Pm to the gross beta radioactivity of the upper layer of one of the cores was also evaluated. (auth)

527 PREDICTION OF MASSIVE WASH-OUT OF NUCLEAR BOMB DEBRIS. Storeboe, Per B. (Norwegian Defense Research Establishment, Kjeller). Health Phys., 11: 1203-11(Nov. 1965).

Problems concerning wash-out of nuclear bomb debris are discussed in connection with prediction of close-in fallout areas. With adequate weather forecasts it should be possible to add wash-out from extended precipitation systems to predictions of dry fallout, for which wind information only is necessary. A diagram based on computation is presented, from which a quantitative estimate of wash-out may be made for locations within the fallout sector when bomb size, wind speed, distance from ground zero, amount of rain, and top height of rain-producing layers are known or independently predicted. (auth)

528 EMANATION OF ^{222}Rn FROM SOILS AND ITS USE AS A TRACER. Pearson, John E.; Jones, Gary E. (Univ. of Illinois, Urbana). J. Geophys. Res., 70: 5279-90(Oct. 15, 1965).

The temporal, geophysical, and geographical parameters related to the emanation of ^{222}Rn at the earth-atmosphere interface were studied. Such information is necessary in the evaluation of boundary conditions for an investigation of the vertical diffusivity of the atmosphere if natural ^{222}Rn is to be used as a tracer. A system for collecting ^{222}Rn emanating at the surface of the earth with a minimum of disturbance to the site was developed. It includes a stainless-steel collector, open on the bottom where it is in contact with the soil; a pump; water and carbon dioxide traps; and chilled traps in which the radon is adsorbed on activated coconut charcoal. Sampling patterns in east-central Illinois were selected using a randomized complete block design to permit statistical analysis of emanation data with respect to location, soil type, meteorological conditions, and other parameters. Although no statistically significant variation of ^{222}Rn emanation with location or soil type was found, a variation with wind speed, gustiness, and soil moisture was observed. Criteria for the selection of locations suitable for vertical diffusivity studies using ^{222}Rn as a naturally occurring tracer should include, ideally, uniform emanation for tens of kilometers in all directions, substantially level topography, and uniform vegetative cover. The location chosen for these studies meets these criteria. (auth)

529 Rb–Sr AGES OF CHONDRULES AND CARBONACEOUS CHONDRITES. Murthy, V. Rama (Univ. of California, San Diego, La Jolla); Compston, W. J. Geophys. Res., 70: 5297-5307(Oct. 15, 1965).

Determinations of Rb, Sr, and K contents and isotopic compositions of Sr are reported for the carbonaceous chondrites Orgueil, Murray, Mokoia, and Lancé, the hypersthene chondrite Peace River, and four chondrules from

the Peace River meteorite. In accordance with previous work, the abundances of Rb and K in type I is greater than in type III; Sr is relatively constant. An isochron constructed from the carbonaceous chondrite data alone indicates an age of 4.46 ± 0.35 Byr, taking λ^{87}Rb equal to 1.39×10^{-11}/year, and an initial $^{87}Sr/^{86}Sr$ of 0.7007. The age becomes 4.74 ± 0.15 Byr if the initial $^{87}Sr/^{86}Sr$ is assumed to be 0.6985 (the mean initial value for achondrites), but the residual variance in the regression now becomes greater than experimental error. Most of the residual variance is contributed by the type III carbonaceous chondrites; one of several possible explanations is that type III formed some 0.3 Byr later than type I by Rb depletion. Inclusion of the data for the Peace River chondrite changes the age only slightly (to 4.76 Byr). The data from the four chondrules scatter widely about this isochron; "geological" error and possibly increased experimental error may be the cause of this scatter. (auth)

530 GALLIUM CONCENTRATIONS IN THE METAL PHASES OF VARIOUS METEORITES. Cobb, James C.; Moran, George (Brookhaven National Lab., Upton, N. Y.). J. Geophys. Res., 70: 5309-11(Oct. 15, 1965). (BNL-9092).

The metal phases of seven chondrites and fourteen iron meteorites were analyzed for gallium by neutron activation. Gallium is quite uniform in the ordinary H- and L-group chondrites and averages 12 ppm. The metal phase of the Abee enstatite chondrite contains 64 ppm Ga. It was previously established that gallium abundances in iron meteorites are distributed around certain unique values. This was postulated to be related to the origin of iron meteorites. It is noted, however, that there is no correspondence between the gallium group and the cosmic-ray exposure age. (auth)

531 A RADIOACTIVE LAYER OVER BARROW, ALASKA, ATTRIBUTED TO THE CHINESE NUCLEAR TEST OF OCTOBER 16, 1964. Gustafson, P. F.; Keener, R. B. (Argonne National Lab., Ill.). J. Geophys. Res., 70: 5323-5(Oct. 15, 1965).

A profile of atmospheric radioactivity taken over Barrow, Alaska, on Nov. 12, 1964, showed a relatively diffuse radioactive layer extending from 4.0 to 7.0 km. This layer was attributed to debris from the Chinese nuclear test on Oct. 16, 1964. (D.C.W.)

532 A GEOCHRONOLOGIC STUDY OF THE LONE GROVE PLUTON FROM THE LLANO UPLIFT, TEXAS. Zartman, R. E. (Geological Survey, Washington, D. C.). J. Petrol., 5: 359-408(Oct. 1964).

Determinations of ^{40}Ar, ^{40}K, ^{87}Rb, and ^{87}Sr in igneous and metamorphic rocks of the Llano Uplift were made. The results suggested that this area was involved in a single orogenic cycle with no later general metamorphism. Samples of granite, aplite, pegmatite, rhyolite, and metamorphic rocks were investigated to determine the precision in Rb–Sr and K–Ar ages between various minerals and different localities. The average Rb–Sr age on microclines, muscovites, and biotites was 1020 million yr and the average K–Ar age on muscovites, biotites, and hornblendes was 1045 million yr (^{87}Rb decay constant, $\lambda_\beta = 1.47 \times 10^{-11}$ yr^{-1}; ^{40}K, $\lambda_\beta = 4.72 \times 10^{-10}$ yr^{-1}, and $\lambda_\epsilon = 0.585 \times 10^{-10}$ yr^{-1}). A total rock Rb–Sr age on one of the granites gave no indication of being older than those of the constituent minerals. The only rock to show a real age difference was a rhyolite porphyry, which gives an average Rb–Sr microcline age of 920 million yr. A metasedimentary gneiss having a total rock Rb–Sr age of 1110 million yr may contain some radiogenic strontium from an earlier history. The K–Ar determinations on several microcline and plagioclases gave ages 5 to 20% low relative to the other minerals, presumably due to argon diffusion from the feldspar. Anomalously low Rb–Sr ages occurred on several fresh biotites from pegmatites and granite, and evidence is presented for strontium or rubidium migration in these rocks. A study of the effects of weathering on the geochronologic systems was made on two obviously altered granites. The only mineral to suffer any decrease in apparent age from such surface alteration was biotite, by the Rb–Sr method. The $^{87}Sr/^{88}Sr$ ratio of the original strontium incorporated into the minerals of the granite was determined on several minerals having low Rb/Sr ratios and was found to be 0.0843 ± 0.0002 (normalized to $^{86}Sr/^{88}Sr = 0.1194$). (BBB)

533 DOSE OF EXTERNAL γ RADIATION FROM DEPOSITED FISSION PRODUCTS IN THE YEARS 1958 TO 1963. Havlovic, V.; Santholzer, V. (Charles Univ., Hradec Kralove, Czech.). Kernenergie, 7: 773-6(1964). (In German).

Measurements of fallout in Hradec Králové were used to calculate the dose of external γ radiation in Czechoslovakia. The method of Geodenov et al. (Kernenergie, 3: 673(1960)) was used. The monthly activity from Nov. 1, 1958, to Dec. 31, 1963, is illustrated, and is used to calculate the integral dose of external γ radiation in Mrad/30 years. The yearly sums are: 1959, 17.4 Mrad/30 years; 1960, 1.8; 1961, 4.5; 1962, 19.8; 1963, 32.0. Activity and dose of fallout in other geographically and climatically different countries (Sweden, Great Britain, U.S.A., U.S.S.R.) are higher, according to literature data, than in Czechoslovakia. Calculation of the dose on the basis of total β activity of the fallout is suggested to produce more satisfactory results than approximation of fission product yields of individual nuclides. The present results agree at least in order of magnitude with those of Dunning for a wet region of the U.S.A. (Hearings before the Subcommittee of the Joint Committee on Atomic Energy, 1963, p.231). The dose is only a fraction of natural γ radiation of terrestrial or cosmic origin. (BBB)

534 THE RADIOACTIVITY IN RAIN WATER, SETTLED DUST, AND ACTIVATED SLUDGE OBSERVED IN THE KAGOSHIMA DISTRICT. REPORT 11. Kitahara, Keida; Akiyama, Takashi (and others) (Kagoshima Univ., Japan). Med. J. Kagoshima Univ., 15: 331-9(Oct. 1963). (In Japanese).

The radioactivity in rain water, settled dust, and activated sludge in the Kagoshima district is reported for the period from October 1959 to December 1962. Radioactivity in fallout and activated sludge decreased gradually early in the period due to the nuclear test moratorium. In 1961, the Soviet Union, USA, and other countries resumed nuclear detonations. During the period of 1961 and 1962, there were about 80 detonations. As a result of these detonations, the radioactivity of rain and settled dust increased immediately and very large activities were frequently observed. The radioactivity in activated sludge increased gradually at the same time. Results show that the human environment has been contaminated by nuclear detonations. (TCO)

535 STUDIES ON FALLOUT PARTICLES. [PART] IV. Mamuro, Tetsuo; Fujita, Akira; Matsunami, Tadao (Radiation Center of Osaka Prefecture). Nippon Genshiryoku Gakkaishi, 7: 485-92(Sept. 1965). (In Japanese).

Highly radioactive fallout particles from the first Chinese nuclear test explosion were examined microscopically. The observed results were compared with those obtained on the highly radioactive fallout particles originating from the Russian nuclear test explosions carried out in the autumns of 1961 and 1962. The Chinese particles, as compared to the the Russian ones, were much lower in specific activity at a given age. The diameter of the Chinese particles ranged up to as large as 20 μ, while the largest of the Russian particles was about 15 μ in diameter. Among the Chinese particles that were examined there were several that had divided coloring (two or more zones), but there were very few like that among the Russian particles. The relation between volume and activity was not so clearly linear for the Chinese particles as in the case of the Russian particles. (auth)

536 NUCLEAR FALLOUT FOLLOWING CESSATION OF TEST EXPLOSIONS IN THE ATMOSPHERE. Santholzer, Vilem (Karlovy Univ., Hradec Kralove, Czechoslovakia). Sb. Ved. Praci Lekar. Fac. Karlovy Univ. Hradci Kralove, 7: 549-55(1964). (In Czech).

Monthly records of fallout and rainout are reported for the period September 1961 to December 1963, at Hradec

Kralove, and tropospheric and stratospheric circulation of radionuclides from various nuclear test detonations are traced from collected data. The last nuclear explosions in the atmosphere were carried out in December 1962. By the International Agreement of August 5, 1963, test explosions in the atmosphere were banned. Megaton explosions in the years 1961 to 1962 formed a stratospheric reservoir of fission products. In 1963, a marked springtime increase in atmospheric fallout occurred which was due to descent of the fission products from the stratosphere to the troposphere, although nuclear tests were no longer carried out in 1963. The fission products collected in the spring of 1963 did not contain any fresh radioisotopes of short half lives. The age of the nuclear fallout obtained at that time was determined by long-term observations of the time-decrease in the activity and estimated also by means of γ spectra of single radioisotopes. By the end of 1963 and at the beginning of 1964 a decrease in the fallout activity to about one-tenth of the values measured in May and June 1963, was observed. Thus from data for the year 1964 it should be possible to calculate the mean residence time of radioactive products in the stratosphere. This value is of importance because the future course of human exposure to radiation from the atmospheric fallout will depend on it. (BBB)

537 RESULTS OF SYSTEMATIC SIX YEARS' MEASUREMENT OF ATMOSPHERIC FALLOUT. Santholzer, W.; Havlovic, V.; Macku, J.; Podzimek, J. (Karlovy Univ., Hradec Kralove). pp 431-40 of Aerosols, Physical Chemistry, and Applications: Proc. of the 1st Natl. Conf. Aerosols, Liblice, Oct. 8-13, 1962. Czechoslovak Academy of Sciences, 1964.

Detailed data are reported on β activity, mainly from $^{90}Sr-^{90}Y$, of fallout collected at Hradec Kralove at monthly intervals over the period November 1, 1956 to December 31, 1960. Autoradiograms showing various nuclides present are shown. (TCO)

538 ISOTOPE SURVEY OF THE KARST REGION OF SOUTHERN TURKEY. Payne, B. R.; Dincer, Turgut (International Atomic Energy Agency, Vienna). 15p. (CONF-650652-6). Gmelin, AED-CONF-65-158-8.

From International ^{14}C and ^{3}H Dating Conference, Pullman, Wash.

The results of a survey of the occurrence of tritium, deuterium, and ^{18}O in the Antalya region of Turkey are discussed in relation to the hydrology of the area. The tritium concentration of the recharge-to-ground water and the inflow to the lakes and reservoirs was estimated by extending short-period observations in the region by using data from stations with longer records. The concentrations actually observed at different locations were compared with the tritium input function and estimates are given of the turnover time of lakes, the transit times between recharge areas and large karst springs and of possible connections between different bodies of water. (auth)

Site Survey and Selection

539 (CONF-650407, pp 381-93) TOPOGRAPHIC INFLUENCES ON DIFFUSION COEFFICIENTS AT A SHORELINE SITE. Walke, Gerald J. (Consumers Power Co., Jackson, Mich.).

Recent dispersion observations on the shores of Lake Michigan indicate that there are phenomena operating at shorelines which greatly enhance atmospheric dispersion. Attempts are made to identify some of these phenomena and to estimate their effect on atmospheric diffusion coefficients applicable to shoreline sites. An army surplus oil-fog generator supplied the volume and density of smoke to determine plume dispersion up to five miles from a shoreline tower under moderate to very poor dispersion conditions. Photographs of smoke plumes were taken from an airplane. Plume dimensions were determined from the photographs using various rectification techniques. Gifford's method, which utilizes gross plume dimensions, was used to determine diffusion coefficients for each experimental run. These visually determined diffusion coefficients were compared to diffusion coefficients derived from turbulence data collected at the shore-line tower. The main conclusion drawn from these experiments is that the current estimates of horizontal diffusion coefficients are inadequate to accurately estimate atmospheric dispersion at a shoreline site. The impact of wind-direction shear and the spatial variation of diffusion coefficients must be factored into the determination of accurate diffusion coefficients for use in hazards evaluations of nuclear facilities on shorelines. (auth)

540 (CONF-650407, pp 394-404) ATMOSPHERIC DIFFUSION EXPERIMENTS ON FRENCH NUCLEAR SITES. LeQuinio, R.; Hugon, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

About 150 atmospheric diffusion experiments were carried out on eight nuclear sites. The method used is not original in its principle but it is in its manner of use, which makes it easy and independent of caprices of the wind. Results obtained confirm the classic model of Sutton but, being obtained on marked relief sites and for long emission times (1 hr approximately), they give lower concentrations than those which would have been calculated. Other experiments are planned to study (1) instantaneous emissions, (2) influence of height of release, (3) influence of particle size, (4) deposition rate versus time, (5) contamination near buildings. (auth)

541 REACTOR SITE CRITERIA. Cottrell, Wm. B. Nucl. Safety, 5: No. 3, 223-6 (Spring 1964).

Problems of reactor site location are reviewed. The AEC position on site criteria is discussed along with that of industry. Conclusions are included. (J.R.D.)

Techniques and Equipment

542 (NP-15557) INVESTIGATION OF SEISMIC WAVE PROPAGATION. Final Report. Willis, David E. (Michigan Univ., Ann Arbor. Acoustics and Seismics Lab.). Nov. 1962. Contract AF 49(638)-911. 29p.

An extensive field measurement program was conducted to record seismic signals generated by earthquakes, underground nuclear detonations, and chemical explosions under varied conditions. Approximately 260 earthquake recordings, 62 underground nuclear recordings, and 200 chemical explosion recordings have been obtained. Most of these data have been analyzed, and a number of technical reports discussing the results have been prepared. The amplitude, spectra, and energy content of the seismic waves from these sources showed differences that could be attributed to source size, depth of the source, the material in which the source originates, different types of source, local conditions at the recording sites, and azimuthal effects around the source. These results show that data on amplitude, frequency, and energy can play an important part in the identification of seismic sources but that further research along these lines is necessary to clarify and delineate their potential uses. An intermediate-depth (1206 feet) well installation for monitoring seismic signals was established and put into part-time operation. The results to date indicate that the background noise is reduced by 15 to 23 db, according to the frequency, and that significant signal-to-noise improvements can be obtained by placing seismometers in wells of this depth. (auth)

543 (NVO-98-9) OPERATIONAL AND SUPPORT REQUIREMENTS PLAN. Interim Progress Report, Task IV. Wilson, George L.; Lewis Miles B. (National Marine Consultants, Anaheim, Calif.). July 30, 1965. Contract AT(26-1)-98. 70p. Dep. mn; $3.00 cy, $0.75 mn.

Recent developments are reported on measuring and recording the amplitude and time of arrival of long period waves at five deep-ocean sites, five atoll sites, and thirty Hawaiian Island sites over a predetermined time. A plan is presented which includes present concepts of support requirements in facilities, supplies, personnel, communica-

tions, and transportation. The scheduling of these requirements is based on the expected periods needed to complete successive events under average conditions prevailing at the locations where these events occur. (M.O.W.)

544 THE NEUTRON MOISTURE METER AND ITS VALUE IN WATER-USE EFFICIENCY STUDIES. Barrada, Y. (International Atomic Energy Agency, Vienna). At. Energy Rev., 3: 195-216(1965).

The principles of the neutron moisture meter, the neutron source, and the relative merits of some of the commonly used detectors (BF_3-tubes, crystal scintillators, etc.) are discussed, and the practical realization of the device is reviewed. Brief indications are given as to how its results will provide information on soil variation with depth, the depth of the active root system, soil moisture content, field capacity and irrigation water requirements. (D.C.W.)

545 PcP FROM THE NUCLEAR EXPLOSION BILBY SEPTEMBER 13, 1963. Buchbinder, Goetz G. R. (Lamont Geological Observatory, Palisades, N. Y.). Bull. Seismol. Soc. Am., 55: 441-61(Apr. 1965).

The BILBY nuclear explosion in Nevada on September 13, 1963 generated core-reflected phases (PcP), which could be identified on seismograms at 26 stations out of 150 whose epicentral distances were such that PcP phases could be expected. The shot was fired in tuff at a depth of 2314 ft below the surface at 1760 ft above sea level. Since the location and origin time of the event are accurately known the travel times are more reliable than those derived from earthquakes. The travel times compared with those of the Jeffreys-Bullen tables of 1958 showed that all the PcP phases arrived early. Thus, PcP received at stations between 19 and 88°, arrived early by an average of 1.80 sec with respect to the Jeffries-Bullen tables. The standard deviation of these data was 0.77 sec. The corresponding P phases were early by 1.34 sec. If the core boundary is to be moved by more than 10 km from the value of 2898 km, the mantle seismic velocity immediately above the core must be changed also. The PcP/P amplitude ratios were nearly always much larger than those predicted theoretically. If changes in velocity near the boundary are admitted, the depth to the core may perhaps be moved outside this limit. All the PcP's that were observed, 26 out of 150 seismograms, gave PcP/P ratios much larger than those predicted theoretically. The direction and distribution of initial phases were random. (BBB)

546 RADIOCARBON CHRONOLOGY OF LAKE LAHONTAN AND LAKE BONNEVILLE II, GREAT BASIN. Broecker, Wallace S.; Kaufman, Aaron (Lamont Geological Observatory, Columbia Univ., Palisades, N. Y.). Gecl. Soc. Am. Bull., 76: 537-66(May 1965).

Eighty radiocarbon ages on carbonates from the Great Basin lakes were obtained, and radiocarbon measurements were coupled with uranium-series isotope measurements. The validity of the ages was evaluated by comparing different materials, chemical fractions of the same material, radiocarbon ages with $^{230}Th-^{234}U$ ages, and chronology based on geomorphic features with that based on stratigraphic units. The possibility of using the $^{230}Th/^{234}U$ and $^{234}U/^{238}U$ ratios was explored for age determination of lacustrine material. Gastropods deposited from Lake Lahontan during the past 20,000 years showed a 45% excess of ^{234}U activity, and those in Lake Bonneville showed an excess of about 80%. Although small amounts of ^{230}Th are initially present in most of the gastropods, the amount is in a nearly constant ratio to that of ^{232}Th making correction possible for this departure from the ideal case. The $^{234}U/^{238}U$ ratio in pluvial lake carbonates does not appear useful for age determination, but a reliable relation exists between the age of the sample and its $^{230}Th/^{234}U$ ratio. Beyond the measurements of the $^{14}C/^{12}C$, $^{230}Th/^{234}U$, $^{232}Th/^{234}U$, and $^{234}U/^{238}U$ ratios, two other quantities of significance are given, the $^{226}Ra/^{234}U$ ratio and the ratio of calcite to total $CaCO_3$ (hence calcite to aragonite). Both of these measurements provide information regarding the validity of the assumption that the shells were closed systems. Equilibrium between ^{226}Ra and ^{230}Th indicated that the system was closed before the last several thousand years. The results suggested that both lakes were relatively high four times: 17,000 years ago; 14,500 years ago; 12,000 years ago; and 9,500 years ago. The downcutting of Red Rock Pass probably occurred during the high-water period about 12,000 years ago. (BBB)

547 DIFFUSION OF SEISMIC ENERGY IN THE NEAR RANGE. Wesley, James Paul. (Univ. of Missouri, Rolla). J. Geophys. Res., 70: 5099-5106(Oct. 15, 1965).

It is assumed that the flow of seismic energy from an underground nuclear explosion or earthquake in the near range (i.e., distances of less than 1000 km) may be estimated by the diffusion equation in cylindrical geometry with a diffusivity varying directly as frequency. A term is included to allow for the dissipation of energy due to the anelasticity of the earth. The mean period and amplitude of a seismogram are thereby derived as functions of the time of arrival and range. The peak particle velocity is derived as a function of range. A preliminary comparison with observations of the seismic waves produced by an underground nuclear explosion indicates satisfactory overall agreement. (auth)

548 THE APPLICATION OF RADIOISOTOPE TECHNIQUES TO WATER ENGINEERING INVESTIGATIONS. Pilgrim, D. H.; Watson, K. K. (Univ. of New South Wales, Kensington, Australia). J. Inst. Eng., Australia, 37: 175-84(July-Aug. 1964).

The value of radioisotope techniques in water engineering investigations in the hydrologic and hydraulic fields is discussed and reference made to the nature of radioisotopes, detecting equipment, and radionuclear methods. Four areas of application of the techniques (surface water, ground water, soil moisture, and sediment and littoral deposit transport) are reviewed with particular reference to recent overseas and Australian work. A number of miscellaneous applications are considered. (auth)

549 THE DETERMINATION OF WATER SUPPLIES IN SNOW DEPOSITS BY AERIAL GAMMA EXPOSURE. Kogan, R. M.; Nikiforov, M. V.; Fridman, Sh. D.; Chirkov, V. P.; Yakovlev, A. F. Meteorol. i Gidrol., No. 4, 51-5 (1965). (In Russian).

Data on water deposits in snow may be obtained by airplane or helicopter recordings of gamma spectrograms of radioelements in such deposits. Dual measurements from aircraft of the total γ intensity in the air gives the supply of water accumulated in the interval between the two flights. The functional dependence of the depth of the deposit and the ratio of the two intensities is tabulated. The concentrations of radioactive species may be calculated from monochromatic spectra recorded while airborne. Tables for determination of water supplies from individual intensities are provided; and data for water deposits in a 20-cm stratum are shown to cause variations in the data collected in the air by 2 to 20%. However, variations in the period between thaw and freezing are only 5 to 7%. Data may also be collected by comparison of any two peaks in the γ spectrum in two flights. Comparison of aerial data with data recorded on the ground showed agreement to within 10%. (BBB)

550 ON THE DETERMINATION OF THE WATER CONTENT OF A SNOW COVER BY THE USE OF GAMMA RAYS AT THE FICHTELBERG METEOROLOGICAL STATION. Henning, Hubert (Instrumentenamt, Potsdam, Ger.). Z. Meteorol., 17: 229-33(1964). (In German).

Measurements were made in March 1963 of the water content of an old snow cover on the Fichtelberg (Erzgebirge). The applicability of a Soviet gamma snow counter to measurement of snow depths found in the central mountains (20 to 120 cm) was compared with a Czechoslovak snow scale with 50 cm^2 surface. Data are presented for the dependence of the impulse number on the distance of the source in air, and on the depth of the snow. The mean water content of the snow cover from 1960 to 1962 was determined for two stations at the Fichtelberg and one at

Brocken. Results of the comparison between the two techniques are tabulated. If a correction factor for decrease of the extinction coefficient from $\mu = 0.0029$ was applied, 99% of all results for this area were measured with sufficient accuracy. If μ decreased by 0.0001, the error in the measurement was 3%. (BBB)

551 . NUCLEAR DENSITY PROBE FOR IN PLACE MEASUREMENT IN DEEP-SEA SEDIMENTS. Keller, George H. (Univ. of Illinois, Urbana). 10p. (CONF-650654-1). Gmelin, AED-CONF-65-167-4.

From Ocean Science and Engineering Conference, Washington, D. C.

A nuclear sediment density probe was developed for in situ measurement of bulk sediment density in the deep-sea floor. Measurements were based on the scattering of gamma rays from a radioactive source contained in the probe. The intensity of the backscatter is detected by a Geiger counter assembly and recorded photographically by a camera in the instrument. Sediment density is directly correlated with the amount of backscatter. After the probe has penetrated the sea floor the source and detector automatically move vertically within the lower barrel of the probe thus obtaining a density profile. Approximately 60 stations can be occupied during a single lowering of the device. The self-contained probe is about 26 feet long and weighs approximately 700 pounds in air. (auth)

Thorium and Uranium Minerals

552 (NP-15534) WORLD URANIUM AND THORIUM RESOURCES. (European Nuclear Energy Agency, Paris (France)). Aug. 1965. 22p. Dep. mn.

Estimates are made of the U and Th resources in the free world which are known to exist or which can be estimated or inferred. The U estimates are for three price ranges ($5-10, $10-15, and $15-30/lb U_3O_8), while the Th estimates are for the range $5-10/lb ThO_2 only. (D.L.C.)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection
GEOLOGY, METEOROLOGY, AND MINERALOGY — Natural Radioactivity and Fallout

Refer also to abstracts 424, 518, 1410, 1416, 1452, 1538, 1542, and 1553.

553 (BNWL-SA-293) UPTAKE AND RETENTION OF ^{65}Zn FROM CERTAIN FOODS. Honstead, J. F.; Hildebrandt, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 13, 1965. Contract AT(45-1)-1830. 9p. (CONF-651014-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Western Industrial Health Conference, San Francisco.

The uptake and retention of ^{65}Zn from the consumption of oysters collected on the Washington coast near the mouth of the Columbia River, was measured by whole-body counting of a man. The subject was counted in a whole-body counter to establish an initial background count. During the next 20 mo. he ate 81 meals of oysters, an average of about one meal per week. The ^{65}Zn content of each entire oyster meal was determined. A total of 13 whole-body counts were made during the period. The total ^{65}Zn ingested by the subject was 709 nanocuries included in 17,430 g of oysters. The maximum ^{65}Zn body burden attained by the subject was 40 nanocuries. It was concluded that the ^{65}Zn content in Pacific oysters does not contribute significantly to the radiation exposure of members of the local population. (C.H.)

554 (CONF-650407) INTERNATIONAL SYMPOSIUM ON FISSION PRODUCT RELEASE AND TRANSPORT UNDER ACCIDENT CONDITIONS, APRIL 5–7, 1965, OAK RIDGE, TENNESSEE. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 1249p. Dep. mn; CFSTI $12.75 cy, $5.00 mn.

Issued in two volumes but cataloged as a unit.

A total of 62 papers, and summaries by session chairmen, were presented in eight sessions entitled: experiments on release of fission products, natural processes affecting fission product transport, atmospheric dispersion of accident-released fission products, nuclear safety programs and facilities, fission product deposition studies, induced removal or retention of fission products within containment system, accident models and hazards evaluation, and sampling, characterization, and trapping of fission products. Separate abstracts were prepared for 48 of the papers. For abstracts of the other papers, see NSA 18: 34045; 19: 44632, 44285, 34407, 34409, 38132, 28575, 34408, 37198, 36700, 44286, 24746, and 28361. (D.L.C.)

For abstracts of individual papers see: 215, 216, 278–282, 514, 539, 540, 555–589, 1348, 1460, and 1461.

555 (CONF-650407, pp 1-37) FISSION GAS AND IODINE RELEASE INTO EXPERIMENTAL COOLANT SYSTEMS FROM PLANNED AND UNPLANNED DEFECTS IN URANIUM DIOXIDE FUEL ELEMENTS. Allison, G. M.; Rae, H. K. (Atomic Energy of Canada Ltd., Chalk River (Ontario)).

A summary is presented of studies of the release of fission gas and iodine from high density UO_2 fuel elements into pressurized water and terphenyl coolants. These releases were from intentional defects (drilled holes) and from failures which occurred during irradiation. The observed release of fission gases from intentional defects in elements of different lengths and ratings has suggested a model in which resistance to radial movement and to axial movement are treated separately. The released gas is assumed to come from the hot central core. First a small fraction of the production is assumed to move readily into cracks in the colder fuel, and then axial movement occurs such that the fractional release is a unique function of the product of element length and decay constant. The release of iodines is lower because they are delayed for a long time between leaving the hot core and reaching the defect. The fraction released is proportional to $\lambda^{-\frac{1}{2}}$. The long delay outside the hot core is an important source of ^{135}Xe and ^{133}Xe, and their release is enhanced accordingly. The absolute amount of the fission gases and iodines released to the loop water from fuel failures has varied greatly but has generally been less than a few percent of that in the fuel. The relative amounts of the fission gases are similar to those from intentional defects which have been adjusted for the contribution from iodine decay outside the hot core. The ratios of the iodine nuclides indicated a much younger mixture was released from failures than from planned defects. Fission-gas release from failed elements into organic coolant has been similar to that into water but iodine release has been lower. Release of ^{132}Te, ^{99}Mo, and ^{140}Ba from failures has also been observed but no quantitative data are available. ^{132}Te has shown great affinity for system surfaces. (auth)

556 (CONF-650407, pp 56-72) FISSION PRODUCT RELEASE FROM COATED PARTICLE FUELS UNDER ACCIDENT CONDITIONS. Morrison, D. L.; Rosenberg, H. S.; Townley, C. W.; Sunderman, D. N. (Battelle Memorial Inst., Columbus, Ohio).

During the development of the coated particle fuels, data on fission product release have been obtained in postirradiation experiments in helium atmospheres at temperatures up to 2000°C for low-burnup specimens. The data from these laboratory studies were examined to determine what effects pyrolytic carbon coatings surrounding the fuel would have upon the release of fission products from the fuel under accident conditions. Although the mechanisms governing the release in postirradiation heat treatments have not been established, some measurements of the time dependence and the temperature dependence have been reported. These data were used to estimate the extent of the release from the fuel following the loss of coolant. If the temperature distribution in the Peach Bottom reactor following a loss-of-coolant accident is assumed to be typical for gas-cooled reactors using coated particle fuels, an average temperature within the core of 1540°C would be expected for a period of 20 to 100 hr after the accident. During this period at the average temperature, a fractional release of krypton and xenon of 4×10^{-7} would be estimated for release from unsupported pyrolytic carbon-coated particles. The fractional release of iodine is estimated at 3×10^{-4}, and the fractional release of barium and strontium would be 4×10^{-2} and 5×10^{-2} respectively. The elemental distribution of fission products released from the coated fuel particles under these conditions is substantially different from the expected distribution during the meltdown of a metal-clad, UO_2-fueled core. The estimated fractional release of barium and strontium from coated particles is higher than that normally assumed under the guidelines of TID-14844 for release of solid fission products to the reactor building. The fractional releases estimated above were for low-burnup samples of unsupported coated particles. The effects of burnup on the fractional release must be evaluated, and since most fuel concepts employ the particles dispersed in a graphite matrix or surrounded by graphite, any retention of the fission products by the graphite bodies would reduce the expected release. Although the barium and strontium release from the coated fuel particles is high, the loss of these metals or their oxides from the core during the accident may be controlled by evaporation or other processes. The possible alterations to the estimated release by these factors based upon the available data in these ares are discussed. (D.L.C.)

557 (CONF–650407, pp 73-93) FISSION PRODUCT RETENTION AND PLATING BEHAVIOR IN LIQUID SODIUM SYSTEMS. Kunkel, W. P.; Schlesinger, G. (Atomics International, Canoga Park, Calif.).

Studies are being conducted on the extent of fission product (particularly iodine) release from sodium. Recent experiments have included high-temperature studies with sodium temperatures of 1000°F for in-pile experiments and 900 to 1400°F for out-of-pile experiments. The results of these studies have corroborated previous data obtained at lower temperatures and indicate that under the conditions studied, less than 0.02% (2×10^{-4}) of the iodine released to the sodium may be available for further release to the environment. Several new experiments are presently in progress. One of these will study the retention or transport of fission products released into a sodium vapor environment to simulate the conditions during some reactor incidents. In this type of experiment, the stored electrical energy from a condenser is discharged through a uranium fuel sample suspended in sodium vapor. The previously irradiated fuel sample melts and fission products are released. The sodium vapor (and fission products) are then purged through a liquid sodium plenum, and the extent of release through the sodium is determined. Previous capsule experiments have not simulated the typical driving force of fission gas to eject fission products and inert gases. An experiment designed to simulate this release condition is being conducted. A small capsule partially filled with sodium and containing a preirradiated uranium fuel disc is evacuated and backfilled with xenon, which at 900°F approximates the fission gas pressure anticipated in a typical high-burnup reactor fuel rod. Following a transient neutron burst to release fission products into the sodium, the capsule is submerged in an 18-in. column of sodium at 1000°F and punctured to release fission products, sodium, and xenon. The resulting activity level above the sodium column is measured to study the extent of release. Samples of surfaces which have been in contact with contaminated sodium at various temperatures and for various lengths of time have recently been obtained from the SRE (Sodium Reactor Experiment) piping, and from high-burnup fuel cladding. Fission products had been introduced into the system in appreciable quantities (several thousand curies) in 1959 as a result of channel blockage and partial fuel melting. Radioactivity was removed from surfaces in the low-temperature input side of the primary loop. The surfaces were successively acid-etched to ascertain the identity and tenacity of plated fission products. Autoradiographs of a visually obvious black stain, subsequently identified by fluorescent and x-ray diffraction as a carbonaceous deposit, indicated definite correlation of the radioactivity observed with this deposit. Samples of gas, sodium bond, and cladding have been obtained from a uranium carbide fuel test irradiation capsule (20,000 Mwd/ton burnup) and radioactivity results correlated with theoretical prediction. (D.L.C.)

558 (CONF–650407, pp 94-117) SODIUM FIRES AND THE RELEASE CHARACTERISTICS OF PARTICULATES AND FISSION PRODUCTS. Jarrett, A. A.; Lauben, G. N.; Koontz, R. L. (Atomics International, Canoga Park, Calif.).

A program is being conducted to characterize sodium fires by determining the influence of initial condition variables and system design parameters on combustion energy release and distribution, and the release of sodium (as oxide or metal) and iodine. A pool fire was conducted in a 5½-ft-dia by 5-ft-deep burn chamber with a conical cover containing four air inlet holes. A heavily thermocoupled 2-ft-dia by 4½-ft-deep burn pot was placed in the chamber. A 600-lb charge of sodium was placed in the pot, heated, and allowed to ignite. A 10-in.-dia pipe connected the top of the cone to a wet scrubbing system, which removed released matter from the effluent air stream. By continuously monitoring the effluent air velocity and oxygen concentration, a continuing oxygen consumption rate was measured. In addition to continuously monitoring temperatures throughout the whole system, periodic scrubber samples were taken to determine the iodine and sodium oxide release. An overall material balance at the conclusion showed that the concentration of iodine with respect to sodium in the released phase was less than one-third that in the residue, and that less than 30% of the sodium was released from the pot. In the companion analytical effort, studies were conducted on fundamental combustion energy and matter released mechanisms and on modeling experimental results to postulated accidents. A postulated gas phase reaction with surface temperature below the boiling point was substantiated by the experimental results and is comparable to the information available on the burning of liquids. A preliminary thermodynamic model for a heat source in an enclosure was developed. Another program is being conducted to determine the particle size distribution of sodium oxides and the release fraction of fission products during the combustion of liquid sodium. Fires are generated from gram quantities of sodium placed in a fixed volume chamber, and from several hundred pound quantities of sodium burned in the apparatus described earlier. The variables of interest, which are measured as a function of time, are oxygen concentration, humidity, particle size, oxide concentration, and the velocity and temperature of the air above the sodium. By appropriately varying these parameters, models are developed which predict the particle size distribution in the environment (above the sodium) as a function of time. This information is used to compute the distribution which either settles or remains airborne. The mass median "aerodynamic" diameter near the surface of a sodium fire was found to be between 1.5 to 2 μ with a geometric standard deviation of approximately 2 μ when measured with cascade impactors. Samples of sodium smoke placed in tranquil settling chambers have equivalent Stokes diameters between 1 and 1.5 μ. High concentrations of sodium oxide, approximately 10^{-6} g/cm^3, cause rapid agglomeration and growth of the particles which reduces the airborne quantity due to the increased settling velocity. (D.L.C.)

559 (CONF–650407, pp 276-91) IN-PILE FISSION PRODUCT RELEASE EXPERIMENTS: ATMOSPHERIC EFFECTS. Miller, C. E. Jr.; Browning, W. E. Jr.; Shields, R. P.; Roberts, B. F. (Oak Ridge National Lab., Tenn.).

The characteristics and behavior of fission products released during simulated reactor accidents are being studied in a continuing series of experiments in which fission products are released by melting miniature stainless-steel-clad UO_2 fuel elements in the ORR. The latest experiments were performed to study the effects of atmospheric flow and composition, and the effects of sustained heating below the melting point of UO_2. The atmospheres employed were dry helium, moist helium, steam-helium-hydrogen, dry air, moist air, and steam-air. Flow rates were varied from 6 to 350 ft/min, evaluated at the fuel melting temperature. In experiments in which a helium atmosphere was used, the stainless steel remained in the metallic form. In experiments in which moist helium was used, there was partial oxidation of the steel, and in the first experiment using a steam-helium-hydrogen atmosphere, there was nearly complete oxidation of the steel. There was complete oxidation of the steel in all experiments in which air was a component of the atmosphere. The most significant variation in the release of fission products as a function of atmosphere is the high release of ruthenium and iodine in moist air from a zone whose minimum temperature is 1000°C. The ruthenium was retained by high-efficiency filters. The iodine penetrated the high-efficiency filters to a greater extent than in other atmospheres but was retained by charcoal. The nonvolatile fission products strontium, barium, zirconium and cerium do not appear to be greatly affected by the composition of the atmosphere, and, under all conditions, less than 1% of the inventory was released from the 1000°C zone. In experiments in which steam was a component of the sweep gas, all fission products investigated except ruthenium appear to be removed significantly from the gas stream by condensing steam. The retention of fission products by condensed water can be expected to be a significant factor in reactor accidents where steam is formed. The re-

lease of the volatile fission products from the 1000°C zone increased 20% between flow rates of 6 and 40 ft/min but did not increase further between flow rates of 40 and 350 ft/min. The release of nonvolatile fission products from the 1000°C zone did not increase between flow rates of 6 to 40 ft/min but increased by a factor of approximately 4 between flow rates of 40 and 350 ft/min. One experiment was performed to study the effects of a long period of heating at high temperature. The fuel in this experiment appeared to have melted even though the temperature never reached the melting point of UO_2. This emphasized the importance of the oxidation state of the stainless steel cladding, since it appears that components of stainless steel, particularly Fe_2O_3, may substantially reduce the melting point of UO_2. The release of fission products from the high-temperature zone indicated the effects of precursors over the long time period. The iodine and tellurium release was lower than in other experiments because their precursors at the time of release were nonvolatile. The strontium and barium release was higher because their precursors were volatile. From this series of experiments, it appears that fission product behavior is substantially affected by the composition of the atmosphere and that changes in its composition caused by vaporization of material near the fuel must also be considered. (auth)

560 (CONF–650407, pp 362-80) SOME THEORETICAL AND EXPERIMENTAL RESULTS USEFUL FOR ESTIMATION OF INHALATION RADIATION DOSE AND ENVIRONMENTAL RADIOACTIVE CONTAMINATION. Lindackers, K. H.; Bresser, H.; Albracht, J. (Technischer Ueberwachungs-Verein Rheinland, e. V., Cologne (West Germany)).

A discussion is given of the various environmental paths which result in the exposure of people residing in the path of the released cloud of radioactive contaminants and which result from their use of real property and agricultural products contaminated by the passage of the radioactive cloud. For the estimation of inhalation radiation dose and environmental radioactive contamination after an accident with fission product escape out of the containment system or reactor building, Sutton's dispersion formula or the Gaussian interpolation formula with more or less practical modification have been used almost exclusively. To relate the various dispersion coefficients of these formulas to the atmospheric conditions taken into account is a difficult task. A comparison was made of ground concentrations calculated with a modified Sutton's dispersion formula and the Gaussian interpolation formula. The main modifications of Sutton's formula are: (1) n = m instead of n = (2m/1 + m), and (2) taking into account short-time variations of the wind direction. The dispersion coefficients of modified Sutton's formula were calculated from experimental equations. Both calculated concentrations are in good agreement and, so far, in agreement with measured SO_2 concentrations in the surroundings of a commercial power plant. Sometimes it is necessary to take into account a strong inversion "lid" at some height above the source. A theoretical calculation is made of ground concentration under those conditions, using a model of repeated reflections. The results for various heights of the "lid" above the source and various stability conditions are compared with results obtained with equations of other authors. To estimate the deposition of fission products by fallout or washout, it is useful to define a deposition velocity. From measurements over several months, deposition velocities were calculated as a function of ground-level concentration and the amount of rain per time interval. The results are in good agreement with those reported by other authors. (D.L.C.)

561 (CONF–650407, pp 439-54) THE DEVELOPMENT AND USE OF METEOROLOGICAL MAP OVERLAYS FOR EMERGENCY PURPOSES AT A POWER REACTOR FACILITY. Lewis, Lionel (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.).

A two-year meteorological study was conducted at the site of the Carolinas Virginia Tube Reactor (CVTR) in Parr, South Carolina. The purpose of this study was to determine the magnitude of the various atmospheric diffusion parameters needed to calculate the radiation dose to persons off-site that would result from a hypothetical release in the event of the "maximum credible accident." These calculations were made for the Hazard Summary Report. To make maximum use of the meteorological data resulting from this study, CVNPA had a set of transparent map overlays prepared for use in case of a major reactor accident. Seven stack-release and two ground-release overlays were prepared, covering the range of meteorological conditions encountered at the site, showing the relative concentrations of radioactivity at various distances from the reactor plant. In the event of a reactor accident, the proper overlay is superimposed over a local area map. Selection of the proper overlay is made by utilizing information on wind speed and direction, wind deviation, and the differential temperature between the top and bottom of a 200-ft instrumented weather tower located at the site which records in the reactor plant control room. Use of these overlays is an integral part of the CVTR Emergency Procedures and is designed to aid those outside agencies, concerned with the health and safety of the public, that would respond to a call for aid in the event of a major accident. (auth)

562 (CONF–650407, pp 455-9) EFFLUENT FLOW IN NON-STACK RELEASES. Culkowski, Walter M. (Weather Bureau, Oak Ridge, Tenn.).

A well-designed chimney or stack will introduce effluent material to comparatively well-behaved air flow. Material emitted at or below the height of adjacent buildings, in contrast, describe extremely complex behavior as is shown by several short films. As a result, downwind dosage calculations lie intermediate between "area" and point source model calculations, evacuation of personnel may be more difficult, and air monitoring of any one spot should be averaged over several minutes while the release is taking place. (auth)

563 (CONF–650407, pp 497-511) MEASUREMENT OF RELEASED FISSION PRODUCTS FROM A NUCLEAR EXCURSION. Bunch, D. F. (Idaho Operations Office (AEC), Idaho Falls).

A model is presented which can be used to estimate, from activity found on air filters, the amount of noble gases released to the atmosphere. The model was developed from data gained during four integral-core destructive tests at the NRTS. The greatest release in any of these tests was about 10% of the noble gases, less than 0.01% of the halogens, and less than 0.001% of the solids which were produced as a result of the excursion. Particle size behavior and deposition measurements are also discussed. (auth)

564 (CONF–650407, pp 512-36) FISSION PRODUCT DISPERSION AND RELEASE FROM THE SNAPTRAN 2/10A-3 DESTRUCTIVE TEST. Cordes, O. L. (Phillips Petroleum Co., Idaho Falls, Idaho).

The reactor destructive experiment conducted on April 1, 1964, consisted of a modified SNAP 10A/2 flight-system reactor mounted in a large water-filled concrete tank. The reactor core contained essentially virgin fuel consisting of 37 zirconium hydride fuel rods formed into a closely packed hexagonal array containing 4.75 kg of ^{235}U, and 464 g-moles of hydrogen. Sodium potassium coolant filled the interstitial spaces between the fuel rods. Six beryllium inserts shaped the core into a cylinder approximately 9 in. in diameter and 13 in. high. The reactor was held subcritical by a final sleeve until the test was initiated, at which time the binal sleeve was removed by a piston, driven by a black-powder charge. Fission product release and distribution data were obtained from fuel remains, environmental water samples, and from a radiological monitoring grid populated with a variety of sampling devices, including high-volume air samplers modified for iodine monitoring, fallout plates, fission-gas detectors, and particle-size samplers. Fission products detected on the grid consisted entirely of daughters of noble fission gases (3 sec ^{92}Kr, 10 sec ^{91}Kr, 16 sec ^{140}Xe, 41 sec ^{139}Xe, and 17 min ^{138}Xe). The ^{138}Cs daughter of

17 min ^{138}Xe was detected in a fission-gas detector designed to hold the longer-lived gases for decay. From the lack of any fission products other than daughters of short-lived noble gases, it was concluded that only noble gases were released to the surrounding atmosphere. Halogens and solid fission products remained in the fuel and environmental water. Fission product release data obtained from the grid were corrected for the portion of each decay chain that was not sampled because the fission product parent was in a gaseous form. These corrected amounts were used to determine the lateral cloud diffusion and the peak isotopic concentration at each grid. These concentration values were used to predict a fission cloud release model that would fit the observed data. The release model was then combined with a Sutton type diffusion equation to obtain the quantity of the fission products released from the reactor. Efforts to determine the distribution of the radioiodine lead to the conclusion that the majority of the iodine remained in the fuel, with the remainder being either absorbed in the environmental tank water or plated out on the concrete walls. (D.L.C.)

565 (CONF-650407, pp 537-56) AIRBORNE RADIOACTIVITY AND CONTAMINATION PATTERNS FROM A TRANSIENT TEST OF A NUCLEAR ROCKET ENGINE. Fultyn, R. V. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The general experimental details of the Transient Nuclear Test (TNT) of a KIWI reactor and the specific details of documenting the resulting release of radioactivity are presented. The instrumented array gave 360° coverage from 100 to 1000 ft of the test point and 90° coverage out to approximately 50 miles. Air sampling instrumentation consisted of high volume air samplers, cycling samplers, and Cascade impactors. Resin coated trays, film badges, and dose rate detectors were placed at stations within the array. Concentrations of airborne radioactivity resulting from the excursion are reported for distances of 4000 ft to 50 miles. Gaseous and particulate activity are reported separately. The empirical data are compared to predictions made using the diffusion theories of Sutton and Pasquill, with actual weather conditions as experienced used as parameters. A comparison is also made of the collected data and pre-event predictions, which used assumed weather conditions as parameters. Close-in site contamination resulting from reactor fragments too large to be classified as aerosols is described, and contamination from fallout is reported for distances of 4000 ft to 50 miles. (auth)

566 (CONF-650407, pp 557-65) THE CHARACTER OF THE EFFLUENT MATERIAL FROM A TRANSIENT TEST OF A NUCLEAR ROCKET ENGINE. Henderson, R. W. (Los Alamos Scientific Lab., Univ. of California, N. Mex.).

The nature of the operation largely precludes the use of "wet chemistry," and fission product activities are determined from gross beta and gamma decay and gamma pulse-height analysis. With the data thus generated, the differences in the effluent of fission product material found and that predicted by theoretical calculations are demonstrated. The sampling array extending to 50 miles allows for the study of the behavior of the material in the atmosphere. Differences in the composition of the effluent cloud between 4000 ft and 50 miles are noted. Changes in the composition of the various fractions are due to chemical or elemental states at various times of collections, removal up-wind from the sampling point, and atmospheric dwell time. The iodine behavior is very complex in this system due to the collection of particulate precursors at close-in stations and the sorption of elemental iodine on nonactive airborne particulates at the far-removed stations. Whenever possible, differentiation of the activation activity from fission product activity is accomplished. Results of fallout activity measurements are presented and compared with the airborne activity measured at the various sampling stations. (auth)

567 (CONF-650407, pp 567-77) ENGINEERING TEST PROGRAM TO INVESTIGATE THE CONSEQUENCES OF A LOSS OF COOLANT ACCIDENT (LOFT). Hauge, O. M.; Matheney, G. B. (Phillips Petroleum Co., Idaho Falls, Idaho).

An engineering test-program is currently being developed to investigate the consequences of a loss of coolant accident for a large-scale water moderated and cooled reactor. The test program will emphasize the investigation of fission product release, transport, and plateout under actual accident conditions. The program consists of five phases: (1) Containment Building Pressure and Leak Tests, (2) Coolant Blowdown Tests with a Dummy Core, (3) Low Power Physics Tests and Power Operation, (4) Loss of Coolant Test with a Radioactive Core, and (5) Facility Cleanup and Post-Test Examination. The nuclear system to be employed will be a pressurized water system containing a low enriched, rod type, oxide core of conventional design, having a power capability of approximately 50 Mw(t). The entire system will be mounted on a railroad dolly to facilitate cleanup and movement from the test building to the examination area (hot shop) following the test. During the performance of the test, the dolly containing the nuclear system will be housed in a dry type containment building capable of withstanding the pressure associated with the coolant expulsion and of limiting the fission product leakage to the atmosphere. (auth)

568 (CONF-650407, pp 578-86) FRENCH SAFETY RESEARCH PROGRAM ON FISSION PRODUCT BEHAVIOUR. Candes, P.; Lavie, J. M.; Barthoux, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Radiological consequences of major accidents for all power plants and research centers, are studied by only one division of the French Atomic Energy Commission. Its experimental program covers a large field which includes: (1) Fission products release from uranium and UO_2 fuels when they are overheated in air, steam, CO_2, and sodium. (2) Fission products behavior in reactor circuits such as transmission through water, transmission through sodium, or trapping by graphite. (3) Particle size studies of airborne radioactivity in containment shells, deposition on walls, and decontamination studies. (4) Filtration by high efficiency devices, charcoal beds, and KI layers. (5) Diffusion and deposition of contamination outside the buildings. Generally speaking, the aim of that work is not to give fundamental or general results, but to complete published information so as to be able to predict consequences of accidents for particular installations which are examined by the Safety Commission. (auth)

569 (CONF-650407, pp 603-8) FISSION PRODUCT RELEASE UNDER ACCIDENT CONDITIONS AND ITS RADIOLOGICAL CONSEQUENCES. A SWEDISH RESEARCH PROGRAM. Linder, Per J. (Aktiebolaget Atomenergi, Studsvik (Sweden)).

For the design of a specific nuclear power plant, the relevant data must be extracted from the comprehensive results available. Even if many links in the distribution chain of fission products from damaged fuel to exposed people are thoroughly investigated there are still some points that are not quite clear. A systematic investigation concentrated on remaining problems will be performed at AB Atomenergi during the next few years. The intention is to make it possible to complete the basis for an adequate application of research results to the design of simple and reliable safety arrangements for reactor power plants and to achieve a background for a realistic hazards evaluation of reactor accidents. (auth)

570 (CONF-650407, pp 609-40) CRITICAL ANALYSIS OF THE BLOWDOWN ACCIDENT. Sunderman, D. N.; Morrison, D. L.; Gieseke, J. A.; Smith, J. C.; Walters, C. T. (Battelle Memorial Inst., Columbus, Ohio).

The blowdown or loss-of-coolant accident in pressurized- and boiling-water reactors is a very complex sequence of chemical and physical processes. The importance of being able to predict the consequences of such accidents has led to substantial experimental programs in the United States and elsewhere to study these chemical and physical pro-

cesses both singly and in combinations. As such information is developed, it must be evaluated as to its applicability to such predictions. Among those things that must be evaluated are the limitations inherent in the data itself such as accuracy, precision, temperature-pressure-geometry-composition range, etc., its applicability or pertinence to the analytical description of the blowdown accident, and its effect upon the predicted consequences of such an accident as developed from the analysis. A program is now under way at Battelle under joint USAEC-Euratom sponsorship to provide such an evaluation. The initial result of this program has been the formulation of a comprehensive outline of the physical and chemical processes which could either directly or indirectly influence the consequences of a blowdown accident. Primary classifications cover fission product distribution prior to the accident, coolant blowdown, heat sources and sinks, heat transport mechanisms, fission product release from the core, and fission product transport and deposition in the pressure and containment vessels. These are further subdivided to indicate individual physical and chemical processes in each phase. As data become available, it is related to a specific item or group of items in the outline. Maximum and minimum values are being established for physical parameters of major importance such as temperature, pressure, etc., to limit the complexity of the analytical treatment. Analytical techniques pertinent to the description of individual processes are being developed and assembled to form a framework which will allow specific data to be evaluated with respect to its pertinence and effect. (auth)

571 (CONF–650407, pp 641-7) SOME THOUGHTS ON THE FISSION PRODUCT RELEASE PROGRAM. Kupp, R. W.; Cagnetta, J. P. (Stoller (S. M.) Associates, New York).

The principal motivation for a fission product release program is to supply data to permit one to evaluate the radioactive content of fluids which might leak out of a final barrier (containment vessel) following any conceivable accident in a power reactor. This is of overriding importance particularly for water reactors. The current "standard" for fission product release, TID-14844, is generally considered to be very conservative. A less pessimistic appraisal of all of the reduction factors could lead to a reduction in the dosage to the public by a factor of as much as 10^6 to 10^7. Siting evaluation studies have indicated that a relatively small reduction in release criteria, on the order of 10 to 100, would significantly ease the siting problem and, hence, would be a worthwhile objective of the fission product release effort. Such a reduction would have to apply to other isotopes as well as iodine. If a principal program objective is to permit relaxation of the siting criteria, then the newer test facilities for engineering evaluation are most important and should receive major emphasis. Principal among these are the Nuclear Safety Pilot Plant (NSPP), the Containment Systems Experiment (CSE), and finally Loss of Fluid Test (LOFT). Continuing laboratory work should be of a supporting nature, e.g., development of instrumentation and sampling techniques. It is believed that the safety R&D programs can only be planned intelligently on the basis of detailed delineation by the Regulatory Authorities as to the specific gaps in present knowledge which, if eliminated, would permit relaxation in licensing policy and practices. It is believed that the largest potential gain in reducing conservatism is in the transport and aging of fission product aerosols once they are released from the fuel. The data for this aging should be developed in an environment similar to that present in an accident situation. In evaluating the aging effects, as indicated above, attention should be given to long-lived bone seekers, such as strontium-90, since if these elements are available for leakage as based on the 1% release assumption, they are in fact a controlling hazard for long life cores of the type currently being proposed. It is recommended that the program to develop innocuous simulants of fission products be given greater emphasis. Efforts should be continued on more advanced systems, e.g., massive uranium carbide, mixed uranium and thorium carbides, etc., but on a low level. (D.L.C.)

572 (CONF–650407, pp 655-97) STUDIES OF FISSION-PRODUCT DEPOSITION IN OUT-OF-PILE LOOPS. Raines, G. E.; Abriss, Arnold, Morrison, D. L.; Ewing, R. A. (Battelle Memorial Inst., Columbus, Ohio).

Deposition of fission products from helium gas streams was measured in out-of-pile loops of stainless steel. Gamma-emitting fission products released from mildly irradiated UC_2 fuel elements were analyzed by means of their gamma spectra. Ten individual loop experiments were conducted with specimen temperatures of 1800°F and maximum gas temperatures of 1200°F. Reynolds numbers varied from ~1000 (laminar flow) to 7000 to 8000. Experiment duration ranged from several hours to 55 hr. The following characteristics were usually found in a plot of gross-gamma activity vs loop position: (1) In isothermal zones, gross activity decreased roughly exponentially. (2) There was an abrupt and significant increase in deposition rate at bends, thermocouples, or other places where the hydrodynamic flow pattern was perturbed. (3) Deposition in heat exchangers increased to a maximum part way through, afterwards decreasing. These patterns were usually much more erratic than in isothermal zones. Several reasons were speculated for this erratic behavior. The behavior of individual fission products, except ^{131}I, was somewhat analogous to that of the gross mixture. Behavior of the fission products in the group, comprised of ^{141}Ce, $^{140}Ba-La$, $^{95}Zr-Nb$, and ^{103}Ru, was quite comparable and was most affected by hydrodynamic disturbances. The volatile elements, ^{137}Cs and ^{129}Te, showed patterns somewhat alike in isothermal zones but with cesium deposition greatly enhanced in the heat exchanger, where tellurium deposition was little affected. Iodine-131 had its own unique deposition behavior. Small quantities deposited in the high-temperature (1200°F) isothermal region. The bulk of it deposited in the heat exchanger, where erratic variations suggested an important temperature dependency. In the low-temperature isothermal zone, iodine deposition appeared to be almost independent of position in the loop. Behavior of iodine proved to be the most difficult of interpretation and the least amenable to theoretical treatment of all of the fission products deposited. To obtain theoretical values of the mass flux, various models of fission product deposition in gas-cooled reactor circuitry have been explored. These aid in correlating and understanding the experimental data from model loop experiments. In all cases, the operation was considered to be steady state. One model, consisting of a simplified boundary-layer problem, considered that the boundary layer was completely destroyed at flow disturbances and allowed for adsorption of the fission product species at the wall. Another model consisted of a finite difference solution of the diffusion equation, allowing for flow and absorption at the wall. Turbulent diffusivities were estimated and employed. Better, but still not adequate, correlation with experimental data was possible with this more complex model. (D.L.C.)

573 (CONF–650407, pp 720-9) FISSION PRODUCT SORPTION BY PROTECTIVE COATINGS. Newby, B. J.; Rohde, K. L. (Phillips Petroleum Co., Idaho Falls, Idaho).

In the Loss of Fluid Test (LOFT) program, a number of fission products, especially the rare gases and iodine, will leave the reactor vessel and enter the atmosphere of the containment building; the iodine is expected, in part, to plate out on the interior surfaces of the containment building. Several synthetic organics are being considered as protective coatings to simulate the interiors of existing and planned reactor buildings and to permit rapid remote decontamination for conducting subsequent LOFT experiments. During the testing of a number of potential protective coatings, an essentially irreversible sorption of iodine was noted which may be of considerable importance in reactor safety evaluations. In the experimental studies, iodine (as I_2) was carried onto the test coupons at 40°C in a stream of moist nitrogen. The coupons were then counted, sprayed with decontaminating reagents in a standard manner, and counted again to obtain iodine sorption and decontamination data. By counting after scraping, it was found that 9% of the iodine had penetrated deeper

than 5 mils in one coating and 61% of the iodine deeper than 2 mils in another. In any reactor, following a loss of coolant or similar accident, the use of the coatings tested would have the effect of scavenging the iodine from the containment building atmosphere and materially reducing the amount of iodine available for leakage from the building. For the special case of the LOFT experiments, use of these coatings also has the possible effect of reducing the significance of the containment leakage because of the reduced concentration of iodine in the containment atmosphere; however, remote decontamination is desirable to permit reuse of the facility. (D.L.C.)

574 (CONF–650407, pp 730-46) THE DEPOSITION OF FISSION-PRODUCT IODINE ON STRUCTURAL SURFACES. Davis, M. E.; Browning, W. E. Jr.; Creek, G. E.; Parker, G. W.; Parsly, L. F. (Oak Ridge National Lab., Tenn.).

Stainless steel, carbon steel, aluminum, brass, copper, zinc, and painted surfaces were exposed to iodine in air; stainless steel and carbon steel were exposed to iodine in helium, hydrogen, and air, all containing steam; and stainless steel with different amounts of surface oxidation was exposed to iodine in vacuum with the sorption rates and surface roughness being measured. General conclusions from these three independent research efforts are that more iodine is retained by both stainless steel and carbon steel in the absence of air, carbon steel retained a factor of 10 to 100 more iodine than does stainless steel and retained more iodine, in air, than any other metal tested, and painted surfaces show wide variation in iodine retention capability. The sorption rate of iodine on stainless steel is markedly decreased on a more highly oxidized surface, surface oxidation increases the roughness of a stainless steel surface, and carbon steel surfaces have roughness factors an order of magnitude higher than do stainless steel surfaces. Stainless steel has exhibited a passivity toward iodine sorption. (auth)

575 (CONF–650407, pp 753-75) FISSION PRODUCT TRANSPORT IN PRESSURE SUPPRESSION CONTAINMENT. Ashworth, C. P. (Pacific Gas and Electric Co., San Francisco, Calif.).

A method is presented for analyzing fission product transport following a maximum credible operating accident (MCOA) in a plant which has a pressure suppression containment system. The method was developed for Humboldt Bay Unit No. 3 and also was used for the MCOA analysis presented in the Bodega Preliminary Hazards Summary Report. Three essentially independent computations are required in this analysis. These are computation of temperature decay curves, pressure decay curves, and fission product transport. These three do not include calculation of fuel meltdown as a function of time and of atmospheric diffusion. The temperature decay curves are plots of temperatures in the dry well and in the pressure suppression chamber as a function of time. After several days, the temperature decay curves for the dry well and the chamber become essentially the same. Temperatures are found by computing energy balances one time step at a time. The results of the temperature decay curve computations are the basis for computing the pressure decay curves. The pressure decay curves are found by computing pressures in the dry well and chamber as a function of time by making mass balances for the air and any other noncondensable gases which may be present. Water vapor is assumed to be present at 100% humidity in the gas spaces. The leakage from the containment is accounted for in pressure decay curve computations. Consequently, different assumed leakage rates will result in different pressure decay curves. The transport of air from the dry well to the chamber (reventing) is important in fission product transport computations because there may be fission products in the air which is revented. The reventing rate as a function of time is determined from results of pressure decay curve computations. The analytical models for fission product transport in the pressure suppression system and from the refueling building to atmosphere are presented. Formulas are developed which account for time-rated fuel meltdown, reventing, entrainment in suppression pool water, containment leakage, decay, fission-product-removal equipment, and time-rated fission product removal from air spaces by fallout, washout, and other removal phenomenon. (D.L.C.)

576 (CONF–650407, pp 776-804) IODINE CLEANUP IN A STEAM SUPPRESSION SYSTEM. Diffey, H. R.; Rumary, C. H.; Smith, M. J. S.; Stinchcombe, R. A. (Atomic Energy Research Establishment, Harwell (England)). (AERE-R–4882).

Simulated fission products in the chemical forms believed to be of importance under reactor accident conditions (elemental iodine, methyl iodide, and particulates) were injected into a steam/air mixture which is sampled after it has been bubbled through a water pond. The effect of chemical additives in the water and of the air/steam ratio was investigated in a small glass apparatus with a steam injection tube 3 mm in diameter. These results were confirmed for a scaleup to a 2-in.-dia tube in a large steady-state apparatus designed to study geometric factors. With this latter equipment, an inlet flow of 600 lb/hr steam, 1200 lb/hr boiling water, and 50 scfm air can be used. The rate of release of the trapped iodine when air is blown through and over the water ponds, and its velocity of deposition onto a wide range of surfaces were also measured. Preliminary results indicate that with a favorable geometry the penetration of methyl iodide, hydrogen iodide, and elemental iodine at high concentrations is limited to approximately that which by Henry's Law can be theoretically predicted to be in equilibrium with the solution formed. However, with low concentrations of elemental iodine (such that the pond water does not rise above 10^{-6} g-mole/liter) the fraction penetrating is much lower than at the high concentrations. This result can only be explained by an increase in the effective equilibrium partition coefficient of iodine at low concentrations between water and air. Some measurements of the partition confirmed this increase. (auth)

577 (CONF–650407, pp 805-13) THE TESTING OF HIGH-EFFICIENCY FILTERS FOR THE COLLECTION OF SUSPENDED PARTICLES. Hasenclever, D. (Hauptverband der Gewerblichen Berufsgenossenschaften, e. V., Bonn (West Germany). Staubforschungsinstitut).

High-efficiency filters are called in Germany "particle filters special grade S" or "special filters S." On account of the high collection efficiency or the low penetration for solid and liquid particle sizes, most of the previously used methods of testing the filters with lesser efficiencies fail here. For testing "special filters S" in Germany, special methods are developed, which are closely related to the German methods for testing particle filters for dust respirators. Acceptance testing and classification of low penetration filters are done with the following three kinds of solids and liquid particles: (1) Testing of the entire filter element with oil fog in which all drops have a diameter below 1 μ and in which more than 80% of the drops have a diameter between 0.3 and 0.5 μ. (2) Testing of sections of the filter element with radioactively tagged natural atmospheric aerosols. The diameter of the particles ranges from 0.3 μ down to several mμ, and the mean diameter is about 0.07 μ. A total of at least 300 cm^2 of filter surface must be used in at least two separate tests. (3) Testing of sections of the filter element with freshly ground quartz dust smaller than 10 μ diameter. The diameter of more than 80% of the particles must be between 0.5 and 2 μ, and the mean diameter is about 1.3 μ. The concentration is about 120 mg/m^3. Only filters whose filtering properties might be thought to deteriorate at high dust loading are tested. For the measurement of the particle concentration in front of and behind the filter in tests 1 and 3, a tyndallometer is used. In test 2, the radioactivity of filter samples is measured. (D.L.C.)

578 (CONF–650407, pp 830-52) SOME EXPERIMENTS RELATING TO THE BEHAVIOUR OF GAS BORNE IODINE. Collins, R. D.; Hillary, J. J. (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)).

To determine the effectiveness of a combination of paper

filter and charcoal bed as a trap for the gas borne activity which could be released by a reactor accident, a number of experiments were carried out in which the various features of postulated accidents were simulated. From these, it appears that the problem of predicting the transport of iodine is dominated by its ability to exist in a number of distinct forms, each of which can be converted into the other under appropriate conditions. Iodine (or iodides) may adsorb reversibly or irreversibly on aerosols. It can react with fuel components to produce compounds some of which such as methyl iodide are both volatile and relatively insoluble in water. Reversible sorption on walls may produce a similar transformation particularly on heating and especially if organic residues from paint or primer are present. On the other hand at high temperatures organic iodides decompose and the addition of air to a reducing atmosphere has been found to produce a marked desorption of molecular iodine from hot steel. The results are compared with activity released into a gas cooled reactor from a deliberately punctured fuel can. Iodine released into steam from Zircaloy-clad uranium dioxide at temperatures up to the melting point of the fuel, was passed through a chain of condensers, bubblers, demisters and filters. The behavior of iodine placed in unirradiated fuel, of tracer irradiated fuel, and of fuel of moderate burnup (100 Mwd/t) was compared. Methyl iodide was found but often as a very small fraction, the majority of the iodine being associated with the condensate. In another experiment, iodine or methyl iodide was also allowed to react with fuel components and released into steam at 700°C. The major constituent found was readily soluble in hot water through methyl iodide was also present. A similar experiment with irradiated fuel is being mounted. (auth)

579 (CONF–650407, pp 885-907) RELEASE OF FISSION PRODUCTS FROM UO_2 OPERATING AT HIGH POWER RATING. Weidenbaum, B.; Lyons, M. F.; Danielson, D. W.; Davies, J. H. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.).

Fourteen 4-rod assemblies were irradiated in the GETR Pressurized Water Loop in a program to obtain the operating limit of UO_2 as a fuel. Pellet and powder fuel rods, 0.5-in. diameter in annealed Zircaloy-2 tubing, were irradiated at progressively higher peak heat fluxes up to 1.4×10^6 Btu/hr-ft^2. A loss of cladding integrity occurred in seven instances during the loop irradiation; four were of the pinhole type, and three involved major rupture of the cladding. Study of the fission products released from the ruptured fuel elements and of the distribution of fission product activity in the irradiated fuel led to the following conclusions: Much less iodine was released from UO_2 fuel failure in the GETR water loop than fission gases. In Zircaloy-2 fuel rods operating at high heat ratings, it was found that iodine is selectively concentrated on the cladding near the top of the fuel rod opposite pellet interfaces and that ruthenium collects in a metallic form at the bottom of the molten fuel column after a burnup of from 0.5 to 1.0 atom % has been reached. These displacements from the usual point of clad penetration, i.e., from the peak axial power position, may explain the reduced release. (auth)

580 (CONF–650407, pp 908-20) POWER REACTOR ACCIDENTS IN PERSPECTIVE. Beck, Clifford K. (Atomic Energy Commission, Washington, D. C.).

The concept of the maximum credible accident, which is deeply embedded in the literature of safety evaluations, is complex and difficult. It is differently defined by various people, and a good case could be made for the opinion that the whole concept is fictitious and impossible. Nevertheless, as now used, the maximum credible accident concept plays two vital roles in current regulatory practice. It is a crucial element in safety evaluation of reactor sites, and it constitutes the mechanism by which the technical requirements of several protective safeguard systems are established. Maximum credible accidents, as they relate to reactors of different types, and as they relate to sharply increasing size of "conventional" reactors, are briefly discussed. (auth)

581 (CONF–650407, pp 921-37) FISSION PRODUCT RELEASE STUDIES FOR THE EGCR. Culver, H. N. (Tennessee Valley Authority, Oak Ridge, Tenn.).

The safety studies supporting the EGCR Hazards Summary Report are made on the basis of the failure of only a limited number of fuel elements, and with a release of only a small fraction of the activity from these failed elements. The basic argument for presenting the hazards analysis on this basis is given, which shows that most accidents, fuel elements will not fail, and, following system depressurization, subsequent failures are prevented by providing adequate core flow. The basic hazards studies relating to depressurization accidents are described and include a discussion of the following general subjects: depressurization studies, core cooling studies, fuel element failure analysis, activity release from core during accident, and activity release to the environment. (D.L.C.)

582 (CONF–650407, pp 938-69) A CALCULATION DEMONSTRATING THE EFFECT OF THE ZIRCONIUM-WATER REACTION ON THE ANALYSIS OF A LOSS-OF-COOLANT ACCIDENT. Baker, Louis Jr.; Ivins, Richard O. (Argonne National Lab., Ill.).

A calculational study demonstrating the application of metal-water reaction data to the analysis of a loss-of-coolant accident in a power reactor was performed. The reactor conceived for the LOFT (Loss of Fluid Test) facility was used as a model with the assumption that the cylindrical UO_2 core fuel pins were clad with 25-mil-thick zirconium. The temperature and the extent of cladding-steam reaction were calculated as a function of time for the core, which was divided into ten sections represented by various rates of decay heating. The calculations were performed for each section by numerically solving two differential equations on an IBM-704 computer. The rate of reaction of zirconium with steam, when the reaction was not limited by the quantity of steam, was described by the parabolic oxidation law. When the reaction was limited by the steam flow through the core, the reaction rate was assumed to be equal to a constant calculated by dividing the mass steam flow rate by the total cladding surface area. An energy balance, in which the energy accumulation in the core and cladding was equated to the chemical energy and decay energy developed in it, was used to calculate the temperature-time history of individual sections of fuel rod. Heat losses were ignored. Several other simplifying assumptions were made, namely that the decay energy was distributed in the same manner as the reactor power, that the temperature distribution across individual fuel rods was flat, and that the heating and reaction of support structures could be ignored. Calculations were performed for four cases according to the availability of steam to the core: (1) unlimited steam availability, (2) a steady flow rate of 1000 pounds of steam per hour through the core, (3) a steady flow rate of 100 pounds of steam per hour through the core, and (4) no metal-steam reaction. With an unlimited quantity of steam available, the cladding began to react in each section when the temperature reached about 800°C. At the time of clad melting, about 5 mils of the cladding (20%) had reacted, but the rate of reaction was so rapid that ignition had occurred, and the reaction went rapidly to completion. In the steam limiting cases (1000 and 100 lb/hr), the temperatures rose less rapidly. In the 1000-lb/hr flow case, the reaction was steam limited after the temperature in each section reached about 1250°C, and, in the 100-lb/hr case, the reaction was similarly limited at about 900°C. In order to compare the results of the calculations, the simple core meltdown model described in the LOFT analysis was used. The core collapse times and the extent of cladding reaction at these times are given. The subsequent reaction of the collapsed core depends on the time required to melt through support structures and the quantity of water available. In the case of small quantities of core falling into a pool of water in the bottom of the reactor vessel, the amount of additional reaction would be limited to about 15% of the unreacted clad unless the metal

temperatures were above 2600°C, the melting point of zirconia. (D.L.C.)

583 (CONF–650407, pp 970-83) A MODEL FOR EVALUATING THE EFFECTS OF ACCIDENTAL RELEASE OF RADIOACTIVE MATERIALS FROM POWER REACTORS. Stauber, E. (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main (West Germany)).

A description is given of a model to calculate the effects of a loss-of-coolant accident, which is considered to be the most severe type of accident with some probability of occurrence at power reactors. The initial stage of this mathematical model, already programmed for a digital computer, leads, as a result of a number of specific applications, to additions. The general method described was derived from the above development. The general formulas are given for the case of a contained loss-of-coolant accident at a nuclear power plant. The particular physical expressions are discussed, and it is shown that they can be adapted to different cases and to experimental data. (D.L.C.)

584 (CONF–650407, pp 984-99) THE INFLUENCE OF ACTIVITY RELEASE AND REMOVAL EFFECTS ON THE ESCAPE OF FISSION PRODUCTS FROM A DOUBLE CONTAINMENT SYSTEM. Karwat, H. (Technische Hochschule, Munich (West Germany). Institut fuer Mess- und Regelungstechnik).

A mathematical method is presented to estimate the fission product release from a double containment system to the environment after an accidental fission product release within the primary containment (e.g., by a loss-of-coolant accident). In the model, the reactor system is enclosed by a first leaktight containment (I), which itself is enclosed by a second containment (II), both containments with specified but different leak rates. For both containments, a materials balance is established which takes into account a time-dependent source strength (the fission product release from the damaged core) and washout or filtration effects in both containments. The removal effects (washout or filtration) were assumed to be proportional to the time-dependent activity concentration within containment I or II. Some remarks are made on double containment systems with pressure suppression systems. The equations were numerically solved by means of a digital computer. As an example for a characteristic 750-Mw (thermal) boiling-water reactor, the iodine-131 release was calculated with different parameters (release temperature from fuel, washout and filtration constants, and leak-tightness of containments I and II) varied. The effects of these parameters on the release of iodine-131 to the environment are discussed and compared with results when the reactor is protected only by a single containment. It will be shown that the main parameter which strongly influences the results is the "washout-constant" which determines the velocity of activity transfer from the gas phase to the liquid phase (or a filter system). Similar results can be obtained when other isotopes are considered. (auth)

585 (CONF–650407, pp 1000-14) ATMOSPHERIC RELEASE LIMITATION TECHNIQUES IN CASE OF A REACTOR ACCIDENT: CRITERIA GOVERNING THEIR CHOICE—PRESENT METHODS. Billard, F.; Lavie, J. M. (Commissariat a l'Energie Afomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

A complete study of the radiological risks involved in the event of an accident is therefore necessary to assess the features of the safety equipment. From this can be determined the minimum coefficient of hazard reduction necessary. This results as a compromise between the type of reactor containment and filter device efficiency, taking into account the minimum mechanical resistance of the reactor building, the local effluent discharge capabilities, and the nature of the gaseous effluent. The different techniques available at present are discussed, and the method of analysis is applied to the different types of reactors investigated in France. A brief description of the solutions adopted for the most typical French reactors is given, with mention of the design of their ventilation and filtration systems. The validity of that method of approach is closely dependent on the available information on emission and transfer of fission products. (D.L.C.)

586 (CONF–650407, pp 1071-9) SOME PHILOSOPHICAL COMMENTS ON ACCIDENT MODELS AND HAZARD EVALUATION. McCullough, C. Rogers (Nuclear Utility Services, Inc., Washington, D. C.).

Research programs developed over these years have improved our understanding of the behavior of nuclear reactor systems under both static and dynamic situations. Our understanding of these mechanisms is much improved but still has many gaps. We must make greater progress in understanding the various accident modes which can occur in power reactors. At the same time, we should consider the usefulness of detailed researches to the hazard evaluations of such plants, in addition to their general usefulness as extensions of our knowledge. However, it is important to recognize the fundamental fact that accidents are, by definition, unpredictable. Therefore, it is well to consider whether the information derived from experiments covering a relatively narrow range of presently foreseen conditions can ever be reliably extrapolated to unknown circumstances. Reduction of released fission product inventories by orders of magnitude under predicted accident conditions are required to assure the safety of the public in the "unpredicted" cases. It appears that such reduction factors cannot be expected from present researches in postaccident fuel and fission product behavior. These factors do appear to be available in the "countermeasure" class of safeguards which serve to reduce the amount of material leakage to the environment after the fact of the accident and the release has occurred. (D.L.C.)

587 (CONF–650407, pp 1080-90) NUBE—A DIGITAL CODE TO EVALUATE THE HAZARDS OF DIFFERENT TYPES OF REACTOR ACCIDENTS. Alonso, A. (Junta de Energia Nuclear, Madrid (Spain)).

An analytical method was developed to assess abnormal behavior and has been coded for digital computation. The method determines the fission product inventory as a function of reactor power, fuel irradiation, and cooling time. It analyzes the fission product behavior within the containment system, when released from the core as a result of an an accident. Finally, the method calculates the atmospheric diffusion of the escaping nuclides under a variety of atmospheric conditions. External and inhalation doses to individuals within the radioactive plume may be assessed at different distances downwind from the reactor. (D.L.C.)

588 (CONF–650407, pp 1162-1203) USE OF CASCADE IMPACTORS FOR ANALYZING AIRBORNE PARTICLES OF HIGH SPECIFIC GRAVITY. Couchman, J. C. (General Dynamics/Fort Worth, Tex.).

Cascade impactors were used to determine the aerodynamic properties of the released plutonium particles in Operation Roller Coaster. The impaction principle is discussed in some detail. The efficiency equation is derived for the infinite slit and circular jet cases. The calibration of the Casella and Andersen samplers is considered, and an analytical method for determining stage efficiencies is described. The effective cutoff diameter and median diameter methods for determining the size distribution are discussed. A comparison of sizing techniques for irregularly shaped particles is given. The use of cascade-impactor-stage efficiencies and lung-deposition efficiencies to determine respirable doses is discussed in detail. (D.L.C.)

589 (CONF–650407, pp 1204-15) DEVELOPMENT OF MEDIUM FLOWRATE, HIGH PURITY PARTICULATE AND IODINE FILTERS. Rodgers, S. J.; Udavcak, R. J.; Mausteller, J. W. (MSA Research Corp., Callery, Pa.).

A program was conducted to develop a high-purity (≤150 ppm total impurities) particulate filter for high-volume air samplers, and an efficient elemental iodine filter. Both filters were required to be completely dissolvable. Of the different fibers evaluated, Fortisan rayon and microfibers (synthetic acetate) were found to be the most promising.

Both these fibers were fabricated into filter mats which gave flow rates of 30–35 cfm and had efficiencies >90% for 0.07-μ dia particles. For the iodine filter, organic fibers were carbonized and activated, and then formed into filter mats. The efficiency was 99.5% at flow rates of 30–35 cfm (face velocity 325 ft/min), and the filter can be dissolved in HNO_3–$HClO_4$ or 5% NaOH. A composite filter consisting of separated mats of Fortisan and carbon fibers was also made. (D.L.C.)

590 (CONF-651103–5) A SIMPLE, PRACTICAL METHOD FOR CALCULATING INTERACTION. Clark, H. K. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 14, 1965. Contract AT (07-2)-1. 26p. (SM–70/30). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

For Presentation at IAEA Symposium on Criticality Control of Fissile Materials, Stockholm.

A simple approximate method is described for obtaining reliable estimates of the interactions between fissile units and reflectors. The fissile units may be either identical or of arbitrary geometry, and may be arranged either regularly or irregularly. Tables are presented from which curves representing the interactions can be plotted. Comparisons between measured values and the results of the calculations are made. (T.F.H.)

591 (GAMD–6623) CRITICALITY OF FUEL REPROCESSING EQUIPMENT. Malakhof, V.; Simon, W. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Aug. 17, 1965. Contract AT(04-3)-167. 20p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Calculations were made on the criticality of fuel particle storage containers. The following fuel particle types were considered: pyrolytic carbon-coated ^{232}Th–^{233}U oxide particles (single containers only), pyrolytic carbon-coated ^{233}U oxide particles (single containers only), and depleted Th–U particles (arrays of containers). The results are presented as k_{eff} graphs. The effects of container dimensions and flooding are considered. (D.L.C.)

592 (K–C–785) REMOVAL OF LOW-LEVEL RADIOACTIVE WASTES BY A SANITARY WATER TEATMENT PROCESS. Schultz, N. B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1965]. Contract W-7405-eng-26. 10p. (CONF-650943–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From American Industrial Hygiene Assn., Industrial Medical Assn., and Health Physics Society, Gatlinburg, Tenn.

A study was made of the cleanup factors obtained across a potable water treatment plant using normal treatment methods. It was noted that the average gross beta radioactivity was reduced by 15% and the strontium beta concentrations by 6%. A summary and evaluation of six-months data obtained from daily field samples of the raw water supply, as well as the finished water product, is included. Sample analysis included determinations for gross beta radioactivity and radiostrontium. The raw water concentrations were less than half of the MPC_w recommended by the National Committee on Radiation Protection. (auth)

593 (KY–500) TESTING OF TEN-TON URANIUM HEXAFLUORIDE CYLINDERS. Pedigo, W. R.; Smith, V. A.; Bernstein, S.; Hamer, W. J.; Myers, J. L. (Paducah Gaseous Diffusion Plant, Ky.). Oct. 22, 1965. Contract W-7405-eng-26. 57p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Work done on destructive testing of large (10-ton) uranium hexafluoride shipping containers is reported. The primary objective of the initial phase of this test program was to compare the structural properties of two types of containers used for storage and transportation of uranium hexafluoride. A total of 12 drop tests were made and the results are reported. (auth)

594 (LA–DC–7469) INTERSTATE COMMERCE COMMISSION REGULATIONS AND PERMITS FOR THE SAFE TRANSPORTATION OF EXPLOSIVES. Noyes, H. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 5p. (CONF-650931–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Explosives Safety Engineering Conference, Albuquerque, N. Mex.

The regulations pertinent to the shipment of explosives are reviewed. The definitions of the various classes of explosives are considered. The procedures used in applying to the Bureau of Explosives for permits are described. Exceptions to the regulations for special shipments are discussed. (D.L.C.)

595 (MLM–1275) ENVIRONMENTAL MONITORING REPORT: JANUARY–JUNE 1965. Adams, P. C. (Mound Lab., Miamisburg, Ohio). July 16, 1965. Contract AT-33-1-GEN-53. 15p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The concentration of radioactive materials detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, is presented for the first half of 1965. The concentration of radionuclides from Mound Laboratory in the Great Miami River was within the maximum permissible concentration recommended by the National Committee on Radiation Protection and Measurements. The concentration of radionuclides in the environmental air was also within the maximum permissible level recommended by the National Committee on Radiation Protection and Measurements. (auth)

596 (NP–15542) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 3, Number 8. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Aug. 1965. 25p. Dep. mn.

Fallout data for Canada for July 1965 show a decrease in radioactivity. Data are presented on total β activity, ^{90}Sr, and ^{137}Cs in atmospheric precipitation and ^{90}Sr and ^{137}Cs content in milk samples. Data are included from reactor environment monitoring studies during the month. (C.H.)

597 (NP–15563) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 3, Number 6. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). June 1965. 25p. Dep. mn.

Data are presented on fallout in Canada during May, 1965. Results of national averages of fallout data for 1964 are included for comparison. Small amounts of short-lived fission products observed in air and precipitation samples collected during the month were attributed to the second Chinese nuclear explosion of May 13, 1965. The radioactivity levels recorded were much lower than those observed after the first Chinese test of Oct. 1964 and were insignificant from a health point of view. Data are included on total β activity, ^{90}Sr, and ^{137}Cs in precipitation samples and ^{90}Sr and ^{137}Cs in liquid milk samples. Results are presented for reactor environmental monitoring studies during May, 1965. (C.H.)

598 (NP–15568) STUDIES ON THE RELATIONSHIP BETWEEN ^{131}I DEPOSITED ON PASTURE AND ITS CONCENTRATION IN MILK. Edvarson, K.; Ekman, L.; Eriksson, A.; Fredriksson, L.; Greitz, U. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). July 1965. 14p. Dep. mn.

An experimental study was carried out to investigate the relationship between a given deposition of ^{131}I on pasture and the subsequent levels of radioiodine in fresh milk from cows grazing on contaminated pasture. Radioiodine in water solution was sprayed on a fenced pasture. Nine lactating cows were taken to the contaminated area and kept there for two days. Thereafter the cows were moved to uncontaminated pasture for six days. This experiment was repeated three times on pastures of different quality. The concentration of ^{131}I in the milk and the milk production from each cow was measured twice a day. In order to get an idea of the equilibrium concentration of ^{131}I after prolonged grazing on contaminated pastures, ^{131}I was sprayed on three pens with the same area as in the first experiments. The cows were kept grazing there for six days, two days on each pasture. The results indicate that there

is a relationship between the nutritive quality of the pasture and the levels of ^{131}I in the milk. The highest concentration was reached when the quality was lowest. It was found that the ratio of the deposition of ^{131}I per unit area, pCi/m^2, to the concentration in milk, pCi/l, was about 10. An attempt was made to estimate the fraction of ^{131}I retained on the herbage consumed by the cows. Therefore the cows were given a single oral dose of ^{131}I and the concentration of ^{131}I in the milk was measured. Thus the relationship between intake and milk concentration of ^{131}I was established. From this relation the daily intake per cow when grazing on contaminated pastures for two days could be calculated. As the total amount of ^{131}I theoretically available for each cow was known, it could be assessed that roughly 10 per cent of the deposited ^{131}I was consumed by the cows. (auth)

599 (NRL-6306) FILTER PACK TECHNIQUE FOR CLASSIFYING RADIOACTIVE AEROSOLS BY PARTICLE SIZE. PART 4. MATHEMATICAL CONSIDERATIONS. Mason, Robert M., Ryan, Peter C.; Hill, Sarah L. (Naval Research Lab., Washington, D. C.). Aug. 9, 1965. Contract AT(49-7)-2435. 9p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Passing an air stream through a sequence of filters having different retentivities effects some classification of radioactive particles by size. Airborne radioactivity was related to particle size by a system of four simultaneous linear algebraic equations in four unknowns. Each equation expresses the total radioactivity collected on a given filter in terms of the total activity for each size group and the probability for particles of that group being trapped on that filter. A preliminary set of filter pack collection data was used to determine a coefficient matrix for the system based on these probabilities. The system was then applied to new data. This procedure can be applied to a variety of filter pack constructions for relating other characteristics of atmospheric particles to particle size. (auth)

600 (ORNL-P-1581) DESORPTION OF RADIOIODINE FROM CLAYS. Jacobs, D. G. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 13p. (CONF-650821-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Clay Minerals Society Meeting, Berkeley, Calif.

Clays and sediments were contaminated with iodine vapor from the oxidation of tagged KI. When the iodine was displaced with dry air preheated to various temperatures, the heat of desorption increased from 7.3 to 16.7 kcal/mol as the surface concentration decreased. These values suggest that the adsorbed iodine is a mixture of HI, which has a heat of vaporization of 4.9 kcal/mol, I_2, which has a heat of sublimation of 14.7 kcal/mol, and adsorbed iodine, which has an even higher energy of desorption. The rate of desorption decreases with decreased surface concentration, and after 24 hours the residual concentration is proportional to the reciprocal of the absolute temperature of the desorbing air. When the water vapor content of the desorbing air is increased, desorption occurs more readily. Most of the iodine is easily removed with tap water, but again it was noted that the desorption rate decreases with a decreased surface concentration. (auth)

601 (RCC-R-176(Add.)) A NEW METHOD FOR LEAK-TESTING SEALED SOURCES OF ^{226}Ra AND ^{228}Th. ADDENDUM. Dwight, D. J. (Radiochemical Centre, Amersham (England)). May 1965. 6p. Dep.; BIS.

This addendum was issued to clarify the quantitative interpretation of results obtained from the leak testing of sealed ^{226}Ra and ^{228}Th sources by the method described in RCC-R-176. (auth)

602 (JPRS-31747) REGULATIONS GOVERNING WORK WITH RADIOACTIVE SUBSTANCES. Kalaydzhiev, Vl.; Popov, Iv. Translated from Durzhaven Vestn., No. 63, 2-6(Aug. 10, 1965). 24p. (TT-65-32242). CFSTI $1.00 cy, $0.50 mn.

Radiation protection regulations are presented for persons working with radioisotopes and radiation sources in laboratories in Bulgaria. Requirements for the design of laboratories and waste disposal are included. (C.H.)

603 ON THE RADIUM CONTENT OF A HUMAN BODY. Novikov, Yu. V.; Titova, I. N.; Polynkova, A. A. (Erisman Research Inst. of Hygiene, Moscow). Gig. Sanit., No. 7, 42-6(July 1965). (In Russian).

The content of ^{226}Ra in 26 samples of tubular bones in the extremities of cremated cadavers was determined. The deceased were from 50 to 82 years old. The radium was determined by the radon content on a scintillation detector. The investigation showed that the average content of ^{226}Ra in a human skeleton amounted to 16×10^{-12} C that produced a bone dose of 2 mber/year. The average ^{226}Ra content in a human body equals 20×10^{-12} C. (auth)

604 THE DISTRIBUTION OF DOSE AND ENERGY AMONG THE MAJOR ORGANS OF A BEAGLE CADAVER EXPOSED TO WHOLE-BODY 1000 KVP X-RADIATION. Maillie, H. D.; Krasavage, W.; Mermagen, H. (Univ. of Rochester, New York). Health Phys., 11: 1155-62 (Nov. 1965).

A method was described that utilizes glass microdosimeter rods in the determination of dose and an estimate of the effective energy at a point within tissue. Lead absorption sleeves containing 0, 0.5, and 1.0 mm of metal were designed to hold three rods and to produce differential responses dependent upon the incident energy. These sleeves were calibrated in air and tested within a presswood phantom. As designed, this technique was found to be of practical value between energies of 150 and 400 kev. Such absorption sleeves were placed within selected organs of a beagle cadaver which was exposed to whole-body 1000 kvp x radiation. A bilateral exposure was compared with a unilateral exposure of either side and was found to produce a more uniform irradiation with regard to both dose and energy. The midline tissue dose throughout the torso of the animal was found to be approximately 93 per cent of the midline air dose, and the mean effective energy throughout the same region was 282 kev (compared to an incident energy of 385 kev). (auth)

605 THE POSSIBLE ROLE OF MOMENTUM IN RADIATION DOSIMETRY. II. EXTENSION TO CHARGED OR UNCHARGED PARTICLES AND IMPLICATIONS. Turner, J. E. (Oak Ridge National Lab., Tenn.). Health Phys., 11: 1163-75(Nov. 1965). (ORNL-P-1091).

An earlier investigation of the possible role of momentum in radiation dosimetry was extended to include charged particles. The earlier work considered neutrons and gamma radiation and the present treatment shows that the results found there can be applied in a consistent manner to the description of the dosimetry of charged particle radiation. The earlier calculations are reviewed, and results are worked out for protons, electrons, and alpha particles. The relation of this work to a recent paper by Ivanov is shown. It appears that new methods of radiation dosimetry, whether in radiobiology or in radiation protection work, can be developed as a consequence of including absorbed momentum or, more generally, other physical quantities, in addition to absorbed energy in the basic definition of radiation dose. (auth)

606 MEASUREMENT OF THE DISTRIBUTION OF STRAY RADIATION WHILE RADIOGRAPHIC EXAMINATION IS PERFORMED IN THE WELDING OF PENSTOCKS UNDER CONSTRUCTION. Ohnishi, Takaaki (Hitachi Shipbuilding and Eng. Co., Ltd., Japan). Hitachi Zasen Tech. Rev., 26: 79-84(May 1965). (In Japanese).

Radiation scattering at a penstock construction site during the radiographic testing of welding integrity was measured for the purpose of detecting areas where radiological personnel might be exposed to radioactivity in excess of proscribed limits. (H.G.D.)

607 CONTAMINATION MONITOR FOR HANDS, CLOTHING AND SHOES. Venverloo, L. A. J. (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). Kerntechnik, 7: 216-20(May 1965). (In German).

A description is given of a monitoring system which was planned for performing routine tests of professionally radiation exposed persons as quickly as possible. For this purpose the so-called trendtest was installed stopping measurements automatically unless a certain number of counts was registered within a certain period of time. Finally the statistical problems of the trendtest are described. Gas flow counters are used for radiation detectors. (auth)

608 NUCLEAR SAFETY. Volume 5, Number 3. Cottrell, Wm. B. (ed.) (Oak Ridge National Lab., Tenn.). Spring 1964. Contract W-7405-eng-26. 69p. GPO $0.70 (domestic), $0.90(foreign).

One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC.

Technical progress is reviewed in 14 sub-sections; separate abstracts were prepared for each. (J.R.D.)

For abstracts of individual sections see: 41, 106, 424, 518, 541, 609, 610, 1416, 1507–1510, 1542, and 1555.

609 AEA CONVENTION ON CIVIL LIABILITY FOR NUCLEAR DAMAGE. Cottrell, Wm. B. Nucl. Safety, 5: No. 3, 221-3(Spring 1964).

Proposed objectives for a convention to enumerate the minimum international standards which must be adopted with regard to civil liability for nuclear damage and to designate the state which shall have exclusive legislative and jurisdictional competence over claims arising out of specific nuclear incidents are reviewed. (J.R.D.)

610 ON THE FEASIBILITY OF COAL-DRIVEN POWER STATIONS. Frisch, O. R. (Cambridge Univ., Eng.). Nucl. Safety, 5: No. 3, 228-30(Spring 1964).

Design of a coal power station is examined. Discussions are included on fuel configurations, oxidant, operation and control, corrosion, and health hazards. (J.R.D.)

611 IONIZING RADIATION DOSE UNITS. Husak, Vaclav. Pikroky Mat. Fys. Astron., 10: 160-8(1965). (In Czech.).

The definitions recommended by the ICRU for the various units of interest for dosimetry, such as the roentgen, rad, and kerma are reviewed. It is pointed out that on the basis of recent work in this field in Czechoslovakia, the meaning of rad for working with radioactive materials has been extended, including the term the total absorbed dose instead of the previously employed integral absorbed dose in defining the unit. The pertinent reports of the ICRU and the handbooks of the NBS are reviewed. (TTT)

612 STUDIES ON THE BEHAVIOUR AND DISTRIBUTION OF RADIONUCLIDES IN THE SUSPENDED MATTER IN SEAWATER. I. ON THE ACCUMULATION AND DISTRIBUTION OF SOME RADIONUCLIDES IN THE SUSPENDED MATTER IN SEAWATER. Nishiwaki, Yasushi (Tokyo Inst. of Tech.); Kawai, Hiroshi; Honda, Yoshihide; Kimura, Yuichiro; Morishima, Hiroshige; Koga, Taeko; Ono, Ryoich. Radioisotopes (Tokyo), 14: 368-73(Sept. 1965). (In Japanese).

The accumulation and distribution of ^{55}Fe, ^{59}Fe, ^{60}Co and ^{89}Sr in suspended matter in surface seawater sampled at Osaka Bay was studied experimentally by fractional filtration. Dry weights and organic and inorganic materials in each fraction were determined. The radioactive concentration of the seawater was adjusted to about 10^{-4} μC/ml for each nuclide. Accumulation of the radioactive nuclides by the suspended matters was observed to reach an equilibrium in about 7 ~ 10 days. The greatest concentration factors per dry weight of radionuclides were obtained in the fraction of large particle sizes, rather than in the fractions of relatively small particle sizes. The distribution of radionuclides in each fraction indicated that the stronger activity of ^{60}Co was observed in the fraction of large particle sizes, while that of ^{55}Fe was in the fraction of small particle sizes. (P.C.H.)

613 RADIOACTIVITY: DISTRIBUTION FROM CRATERING IN BASALT. Bonner, Norman A.; Miskel, John A. (Univ. of California, Livermore). Science, 150: 489-93(Oct. 22, 1965). (UCRL–14211).

Samples of airborne and ground-deposited debris produced by an experiment in nuclear excavation were analyzed to determine the fate of various radioactive nuclides. A few tenths percent of the nonvolatile species and 10 to 20% of the volatile species escaped beyond the immediate vicinity of the crater. (auth)

614 PREDICTION OF NEAREST SAFE DISTANCES FOR THERMAL RADIATION OF NUCLEAR WEAPONS. Kaufman, W. C.; Pitman, James C. Jr. (Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio). 3p. (CONF-650441-2). Gmelin, AED-CONF-65-094-2.

From Aerospace Medical Association, 36th Annual Scientific Meeting, New York.

Data on biological responses of human beings to the thermal radiation produced by the explosions of nuclear weapons are limited to those from World War II experiences with atomic devices. This information is understandably imprecise. Data from animal studies in later nuclear field testing have supplemented earlier information. Field studies are presently prohibited by international agreements but the determination of thermal safe distances continues to be of importance for civil defense planning and military operations. If this problem were of academic interest alone, large errors on the conservative side could be readily tolerated. However, the nearest safe thermal distance is of real importance to the military planner. Time-distance-intensity relations for a variety of weapons are provided by the Atomic Energy Commission in their "Nuclear Bomb Effects Computer," a circular slide rule. The information from this device has been plotted showing the intensity-distance relationships for four weapons, starting with the 20 kiloton atomic weapons of World War II. The time required for emission of 80% of the thermal energy for each is also shown, as are the computed points of first and second degree burns. Data are included on the temperature changes of human skin caused by exposure to intense thermal radiation. Techniques were developed to measure subdermal temperature by fine wire thermocouples as well as skin surface temperature by radiometer. These data have been collected during exposure of the unprotected dorsum of the hand to irradiances of the magnitude that occurs in atmospheric explosions of weapons of 0.500 to 15 megaton yields. The maximum temperature at the time of intolerable pain was measured by subdermal thermocouple during exposures to 0.20, 0.23, 0.26, 0.36, 0.48 and 0.70 cal/cm^2/sec. The data from 58 experiments on 8 subjects were plotted against time along lines of constant irradiance. Data are also included on the attenuation of thermal radiation by various optical filters. Comparison of the biological data with the computer values indicates that the computer solution for the smaller devices may not be as conservative as it should be, although it compares with actual findings on the atomic explosions in Japan. (C.H.)

615 A DEPOSITORY FOR CONTAINERS OF RADIOACTIVITY POSSESSING SUBSTANCES. Gattys, Franz-Josef. British Patent 1,002,069. Aug. 25, 1965. Priority date Mar. 24, 1962, Germany.

A depository for containers of radioactive material consists of a stationary radiation-proof water- and air-tight passage adapted to store the containers of material in a single line. The containers are so arranged that a progression of containers can move through the passage. When a test must be carried out on the containers, the containers are removed from the progression one by one at one end of the passage and then entered back into the passage at the other end, or a plurality of passages may be interconnected so that the containers removed from one passage may be inserted into an adjacent passage. The passage(s) may be completely underground or may be rendered safe from radiation by soil piled over the confines. (B.L.M.)

616 CONTAINER FOR RADIOACTIVE MATERIAL. (to Abbott Labs.). British Patent 1,003,179. Sept. 2, 1965. Filed May 24, 1962.

A device for shipping and storing radioactive material

is made up of a primary container for containing the radioactive material and a secondary shielding container. The primary container has a body portion and a base portion having an oblique floor and at least two side walls in the base portion. A shoulder portion is disposed adjacent to the inner end of each wall and is spaced at an equal distance from the top of the primary container. The primary container has a neck with means to receive a screw-threaded cap. The secondary container completely encloses the primary container and has a substantially flat floor and at least two projections having a supporting surface. These projections are positioned to accommodate the walls of the base portion having an oblique floor of the primary container between them. The projections also contact the shoulder portion of the primary container on the supporting surfaces, are of equal length, and are of a greater length than the longest side wall of the primary container. (B.L.M.)

INSTRUMENTATION

General

617 (AD-611540) NUCLEAR WEAPONS EFFECTS ON SHIPBOARD ELECTRONIC SYSTEMS. VOLUME 2. ANALYSIS OF ANTENNA STRUCTURES FOR BLAST LOADING. Final Report, Vol. 2. Levy, Roy (American Machine and Foundry Co., Greenwich, Conn.). May 24, 1962. Contract NObsr85266. 166p. CFSTI $5.00 cy, $1.00 mn.

The objectives of the program are to develop methods to evaluate vulnerability of shipboard electronic systems, to illustrate application of the methods, and to formulate design criteria and analytical techniques that will be used to determine construction or modifications of equipment when this equipment must remain operative after exposure to a specified weapon environment. An analytical method used to predict blast-induced dynamic stresses of shipboard antenna structures is presented. (TCO)

618 (AWRE-O-58/65) THE THIN FILM THERMOMETER AS A TRIGGERING AND MEASURING DEVICE IN A SHOCK TUBE. Allen, R. W.; Burch, R. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1965. 36p. Dep.; BIS $1.40; HMSO 7s. 0d.

The fast response resistance thermometer of the thin wire or thin film type is used in many aspects of air flow and heat measurement. Because of its small size and very fast response it has many applications in the operation of shock tubes. The theory, manufacture and application of the thin film type and in particular the design of a shock velocity measuring system are discussed. (auth)

619 (AWRE-O-59/65) THE 30 x 18 in. SHOCK TUBE. Mead, K. F.; Uppard, J. E. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1965. 21p. Dep.; BIS $0.90; HMSO 4s. 6d.

A large shock tube, 120 ft long and 30 × 18 in. rectangular cross section is now working at Foulness. Details of the construction of the tube, the expected performance data, and some details of results obtained in the testing period are given. The tube provides a research tool for the study of a wide variety of problems on the shock and drag forces on model structures, and for the study of more fundamental problems of shock wave and drag phenomena. (auth)

620 (COO-401-118) DEVELOPMENT AND CALIBRATION OF THE PR-3 FLOWMETER. Wood, Rex C.; Graf, Leonard R.; Nelson, Lawrence V. (Litton Systems, Inc., St. Paul, Minn. Applied Science Div.). Aug. 1, 1965. Contract AT(11-1)-401. 75p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

A high-altitude air turbine flowmeter, PR-3, was designed for mounting in the blower exhaust duct of balloon-borne air sampling equipment. The PR-3 is easily repairable and is more reliable than PR-2. A description is given of its design, calibration, operation, and maintenance. (D.L.C.)

621 (LA-DC-6978) NEUTRON RADIOGRAPHY UTILIZING GADOLINIUM ACTIVATION FOILS. Blanks, B. L.; Garrett, D. A. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 25p. (CONF-651021-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 25th National Convention of the Society for Nondestructive Testing, Detroit.

The response to thermal neutrons of gadolinium foils, in combination with radiographic film, was investigated for use in neutron radiography. Class-I, Class-II, and Class-III film speeds are presented as functions of film-foil geometries, and of gadolinium activation-foil thicknesses in the 0.0001- to 0.00623-in. range. Internal-conversion electron and photoelectron emission from gadolinium, applied to the neutron radiographic process, is discussed, as is progress in resolution studies. Optimum film speeds are obtained by utilizing a 0.00027-in.-thick gadolinium foil in a back-film geometry and a 0.0045-in.-thick foil in a front-film geometry. Radiographs of optimum resolution are obtained from the back-film technique. (auth)

622 (LA-DC-7149) REMOTE POROSIMETER. Hull, Pieter L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 6p. (CONF-651101-3). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 13th Conference on Remote Systems Technology, Washington, D. C.

A commercial porosimeter using pressurized mercury was converted for remote use on highly radioactive samples. The equipment modifications which are described include: pentrometer assembly, loading fixture, filling device, and pressure chamber. (D.L.C.)

623 (NP-15529) MEDICION DE DENSIDAD POR RETRODISPERSION GAMMA: BASES PARA EL DISENO DE EQUIPOS APLICABLES A SUELOS Y OTROS MATERIALES. Informe No. 137. (Measurement of Density by Gamma Scattering: Basis of the Design of Equipment Applicable to Soil and Other Materials. Note No. 137). Castagnet, Antonio C.; Di Gregorio, Humberto; Doedderer, Jorge F.; Vignolo, Antonio D. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1965. 40p. Dep. mn.

The operation theory of surface density gages based on gamma scattering and the influence of the various measuring process parameters on signal-density relation was analyzed, to establish the general design principles and the intrinsic limitations of these instruments. The experiments proved that varying the source-detector distance of the device, it is possible to determine the transfer function, the optimum source-detector distance and the calibration curve for any material, using only one sample of known density. Starting from this idea a prototype was developed (its main characteristics being described), which offers the particular advantage of easy calibration for any substance in the density range from one to three grams per cubic centimeter. The measuring unit (probe) is associated to a transistorized portable scaler showing automatically in digital readout the time elapsed to accumulate 10,000 radiation pulses, with error less than 0.1 second. Density is obtained by insertion of said value in the calibration curve. The time required for one density measurement is usually less than 5 minutes; the accuracy being comparable with the results of conventional methods. (auth)

624 (SC-DC-65-1507) COMPARISON OF HEAT-FLUX SENSORS USING THERMAL RADIATION SOURCES. Barber, J. A. (Sandia Corp., Albuquerque, N. Mex.). June 1965. Contract AT(29-1)-789. 11p. (CONF-651002-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Instrument Society of America, 20th Annual Conference, Los Angeles.

An investigation of discrepancies observed in measurements of thermal flux rates from radiating graphites is reported. Simultaneous measurements were made using thermal flux sensors of three different designs. Similar measurements were made of thermal flux rates from quartz infra-red lamps. Thermal flux sensors having 180° view angles without windows and 90° view angles with quartz windows were used in the investigation, the purpose being to examine the effects of possible emissivity changes on the unprotected sensors. (auth)

625 (SC-TM-65-268) A HIGHLY STABLE TEMPERATURE CONTROL UNIT FOR MEDIUM VOLUME TEMPERATURE CHAMBERS. Dugan, Virgil L. (Sandia Corp., Albuquerque, N. Mex.). June 1965. Contract AT(29-1)-789. 21p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A system was designed to control the temperature of medium volume environmental chambers within 0.1°F of a desired temperature. This control system is particularly

applicable to the Statham Model SD-6 chamber; however, the control scheme itself could be used for practically any application. (auth)

626 (SCL-DC-65-92) FRINGE COUNTING LASER INTERFEROMETERS FOR INDUSTRIAL LENGTH MEASUREMENT [Thesis]. Foster, J. D. (Sandia Corp., Livermore, Calif.). Sept. 1965. Contract AT(29-1)-789. 204p. Dep. mn; CFSTI $6.00 cy, $1.25 mn.

Submitted to California Univ., Berkeley.

The use of fringe-counting Michelson interferometers for length measurement has been restricted due to the problems of short measuring range and sensitivity to disturbance. The helium-neon gas laser is shown to be the answer to these problems. Use of the gas laser is shown to remove the measuring range limitations and to permit the design of solid integral interferometer systems with ruggedness and reliability, which allows their use in normal industrial environments. A theoretical model for the Michelson interferometer illuminated with a helium-neon gas laser (laser interferometer) is presented. Calculations of the variations in interference fringe visibility as a function of measuring distance made with this model are shown to agree with experiment. Design considerations for stabilized single-frequency laser cavities are given. A solid integral interferometer system with fringe counting electronics is described. Experimental results are given, which demonstrate the accuracy and long-range measuring capabilities of the system. (auth)

627 (UCRL-16357) TECHNIQUES OF MAGNETIC-FIELD MEASUREMENT. Watson, Peter G.; DiGregorio, Ronald F. (Lawrence Radiation Lab., Univ. of California, Berkeley). Aug. 31, 1965. Contract W-7405-eng-48. 20p. (CONF-650922-2). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From the 1st International Symposium on Magnet Technology, Stanford, Calif.

A survey of techniques of magnetic measurement is presented. Emphasis is placed on the inherent advantages and limitations of each method, on recent improvements, and on the degree of accuracy attainable. Magnetic measuring systems are considered. Factors such as positioning equipment, data recording and processing, and overall cost of measurement are discussed in terms of two systems now in use at the Lawrence Radiation Laboratory—the "search-coil Zip-Track" system and the "Rapid Mapper." (auth)

628 THERMAL NEUTRON RESPONSE AND INTERMEDIATE AND FAST NEUTRON PERSONNEL DOSIMETRY WITH SILVER-ACTIVATED PHOSPHATE GLASSES OF DIFFERENT COMPOSITION. Becker, K.; Tuyn, J. W. N. (Juelich Nuclear Research Establishment, Ger.). Health Phys., 11: 1225-39(Nov. 1965).

Recent radiophotoluminescent glasses are superior to photographic film and other methods used in personnel dosimetry in many respects. However, one of the main problems for the practical application which is not yet solved, is the dosimetry of intermediate and fast neutrons, because the glasses are almost only sensitive to thermal neutrons. The thermal neutron sensitivity of glasses with different compositions has been calculated. The experimental results correspond fairly well to the calculation. The effect of ^{6}Li and ^{10}B enrichment and of the glass dimensions on the thermal neutron sensitivity was also calculated. Special attention was given to Sm, Eu and Gd containing glasses. Only the Gd-glasses could be used for RPL measurements. Among the different possibilities of increasing the fast neutron sensitivity of the glasses, the use of the dosimeter wearer's body as a moderating and back-scattering medium seems to be of particular interest. So it is, for instance, possible to obtain a rad-equivalent neutron and gamma indication of a Yokota-type glass by the frontal irradiation of the glass on the surface of a thorax phantom with fission neutrons. If the neutron spectrum or the angle of incidence is different, correction factors have to be used. These factors could be obtained from the determination of the dose differences in glasses shielded by different neutron absorbers, or by the use of glasses with different neutron sensitivities but the same gamma sensitivity. Results of experiments are given for varying moderator thicknesses, different directions of incidence, fission and Am/Be neutrons and Sn and Cd shielded 8 × 8 × 4.7 mm silver-activated phosphate glass blocks. Some other methods of possible interest are discussed. (auth)

629 OBSERVATIONS OF BACKSCATTERED GAMMA-RAYS IN A SURFACE DENSITY GAGE. Uemura, Teiji (Osaka Prefecture, Nishiku). Jap. J. Appl. Phys., 4: 667-76(Sept. 1965).

Energy spectra of ^{137}Cs gamma rays backscattered from materials of various densities into a surface gauge of the soil density meter were measured by means of an NaI scintillation counter. Changes in the spectra of scattered gamma rays caused by varying the density were inferred from calculations for Compton single scattering. The density-intensity relations were obtained by calculations and experiments for several energy regions with several different source-to-detector separations. The plots of measured gamma intensities from water and paraffin deviate from the density-intensity curve. The deviations depend on the source-detector separation and also on the response of the detector to gamma rays. The gamma intensities observed for densities from 0.44 to 2.47 g/cm^3 fit well into a simple experimental equation. (auth)

630 A SIMPLE SHORT CIRCUIT SPARK GAP FOR COLLISION CURRENT INSTALLATIONS. Wilhelm, Rolf; Zwicker, Hartmut (Technische Hochschule, Hanover; Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Angew. Physik., 19: 428-31(1965). (In German).

The principle of a two-electrode short circuit spark gap is discussed. A simple construction resulting from these principles that was tested on a fast theta-pinch battery with currents of 1.5 mamp was described. The safe ignition of the short circuit gap at very low load inductivity was made possible through the use of ferrite rings in combination with a prespark gap. (tr-auth)

631 PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, CHICAGO, ILLINOIS, OCTOBER 28, 29, AND 30, 1963. VOLUME XIX. Chicago, National Electronics Conference, Inc., 1963. 832p. (CONF-284).

Ninety-five papers are included; separate abstracts have been prepared for two. Nine papers were previously abstracted; see RDA 8: 390, NSA 18: 7825, 7826, 7827, 9547, 10321, 10358, 21540, and 27779. Papers not abstracted deal with the following: nanosecond computing and switching circuits; antennas and propagation; infrared detectors, communication theory; electronic control and simulation, infrared systems; advanced computer technology; energy beams as working tools; engineering management; communication techniques; audio systems; equipment applications of integrated circuits; network theory; magnetics; electrostatic and potential fields; biomedical engineering; transistor applications; parametric amplification; and instrumentation. (L.B.S.)

For abstracts of individual papers see: 695 and 1296.

632 COMPARATIVE EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF THE NEUTRONIC METHOD FOR MEASURING THE WATER CONTENT IN SOIL. Haahr, V.; Oelgaard, P. L. (Forsogsanlaeg Risoe, Roskilde, Denmark). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-65/7, 19p. (CONF-650614-2). ORINS.

From Symposium on the Use of Isotopes and Radiation in Soil-Plant Nutrition, Ankara.

At the Research Establishment Risö of the Danish Atomic Energy Commission a series of comparative experimental and theoretical investigations of the neutronic method for measuring the water content in soil was carried out. The experimental investigations comprised calibration measurements with a sub-surface soil moisture probe. Measurements of the count rate as a function of water content in the range of 0 to 35 volume per cent were performed for five different types of Danish soil. At the same time theoretical investigations, based on three-group diffusion theory, were carried out to see to what extent the experimen-

tal results could be reproduced by calculation. By the use of the actual composition of the soils considered, and by correction of the experimental results for density variation by a theoretical method, excellent agreement was obtained. The variation of the density, the hydrogen content and the absorption cross-section of the dry soil was studied by the theoretical method derived. It was found that a deviation of the density of the dry soil of 0.1 g/cc as compared with the calibration curve density resulted in an error in the water content of about 1 volume per cent. Similarly a variation in the hydrogen content of the dry soil of 0.1 per cent and a variation in the boron content of 30 ppm led to errors of from 1 to 1.2 and from 1 to 2 water volume per cent respectively. The concept of the sphere of influence is examined in detail, and a number of objections are raised. Consequently a new concept, the sphere of importance, is introduced which shows good agreement with theory and measurements. An approximative, simple formula for calculation of the radius of the sphere of importance is given. (auth)

633 PERMANENT AUTOMATIC CONTROL OF IRRIGATION FROM ABOVE OR BELOW BY A NEUTRON PROBE REGIME. Scharpenseel, H. W.; Pennigsfeld, F.; Dequin, K. (Universitaet, Bonn). 10p. (In French). (CONF-650614-3). ORINS.

From Symposium on the Use of Isotopes and Radiation in Soil-Plant Nutrition. Ankara.

The system is only applicable in areas of sufficient uniformity of the soil properties and of plane relief. It is of particular interest in the climatic regions where irrigation water is precious or brackish, and where its excessive use is only accelerating the salt accumulation in the upper horizons. Basic precondition of the irrigation control mechanism is the establishment of the capillary potential curve as well as the neutron probe humidity test curve of the soil. The moisture contents at the level of field capacity and wilting point, taken from the capillary potential curve, are transformed into activity levels, as offered by the neutron probe test curve. They are taken as upper and lower ceiling for the setting of two transistor-relay circuits in the recording instrument of a neutron probe. Whenever the soil humidity approaches the threshold value representing the wilting point a magnet valve in the main water supply is opened. It will be closed again as soon as the soil moisture content produces the activity level standing for the field capacity. Thus, it is ensured that the plants are never lacking moisture, but irrigation water is dosed on demand, rendering water economy and limiting salt accumulation. An experimental setup for irrigation from above and below is described. Attachment of a recorder to the neutron measuring ratemeter gives complete information about the irrigation needs throughout the vegetation period and the level of evapotranspiration. (auth)

634 LIQUID METAL LEVEL TRANSDUCER/Q-2127/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1142).

8 drawings.

The element described is used to measure levels of liquid metal for the Space Power Program. It consists of a recorder, a regulated d-c power supply that operates from 0 to 18 v at 0 to 3 amp, and a microphone cable. (For Details, See TID-4100) (M.C.G.)

635 SQUARE WAVE GENERATOR (Engineering Materials). (Lawrence Radiation Lab., Univ. of California, Livermore). (CAPE-1218).

4 drawings.

The generator described is part of a system used to apply 1500 v, d-c "bias" to a pair of deflection plates. The plates have 1500 and 0 v potentials. The resultant beam bending prevents accelerated particles from reaching a target. When a 1500-v negative pulse is applied to the plate that was initially positive, the voltage difference is zero, and the beam will pass to the target. The rate generator for the system is essentially a square-wave generator with a frequency extended to 10% with the trigger circuit moved. The synchronizing signal is fed through a 0 to 300 μsec variable time delay, cascade amplifier, and multivibrator cathodes. The time jitter is $\sim 10^{-9}$ sec. Synchronized operation is possible from 1 to 2 v (rms). The unit houses a scope and wave form generator. This monitoring device is severely limited in response, 500 kc/s. The scope may demonstrate the over-all action of the beam pulsing system by feeding its inputs from the deflection plate pick-off or a double pulser. (For Details, See TID-4100) (M.C.G.)

636 IGNITRON IGNITOR PULSE TRANSFORMER (Engineering Materials). (Lawrence Radiation Lab., Univ. of California, Livermore). (CAPE-1318).

10 drawings.

The 1:1 ratio low-leakage inductance pulse transformer is used for ignitron ignitor pulsing applications. It provides up to 20 kv of primary to secondary voltage isolation for intermittent duty applications in capacitor bank discharge duty. The normal ignitor firing pulse applied to the primary is obtained by discharging a 0.2-microfarad capacitor charged to 3 to 5 kv through a hydrogen thyratron. (For details, see TID-4100) (M.C.G.)

637 NULL DETECTOR (Engineering Materials). (Iowa State Univ. of Science and Tech., Ames). (CAPE-1310).

8 drawings.

The Field Effect Transistor (FET) allows the design of simplified solid-state circuitry, which fulfills the requirements for a sensitive device to detect the null condition of a low frequency a-c impedance bridge. The FET is the basis for the high-input-impedance, low-noise-input stage of a high Q amplifier. The circuitry, which is most useful at frequencies below 50 kc, consists of two loops of narrow band application followed by the phase discriminator. The detector has an over-all bandwidth of 0.5 cps, at 400 cps and an input-shorted noise voltage of ~50 nv with a 3-sec time constant. The 60 cps rejection is ~100 db. (For Details, See TID-4100) (M.C.G.)

638 PULSE GENERATOR, 25 V (Engineering Materials). (Lawrence Radiation Lab., Univ. of California, Livermore). (CAPE-1256).

26 drawings.

The generator described has a trigger to each channel that starts a delay of variable length, which can be set on the front panel. After the delay period, a variable length gate is triggered which, after amplification, provides the output pulse. The input is 10 to 150 v with a width of 0.5 to 5 μsec and a maximum repetition rate of 200 kc. The output is a 25-v, rectangular pulse with a width of 0.1 to 120 μsec in 0.2 ranges. The jitter is <0.1% gate width. The rise time is 50 ns and the fall time is 100 ns. The load is >200 ohms with a duty cycle of <40%. (For Details, See TID-4100) (M.C.G.)

639 TIME DELAY CHANNELS (Engineering Materials). (Lawrence Radiation Lab., Univ. of California, Livermore). (CAPE-1214).

11 drawings.

Two time delay channels that are independent of each other, except for common power supplies, are contained in a standard rack-mounted chassis with a 7-in. front panel 13.75-in. deep. Front panel controls consist of an a-c power switch, a 3-amp fuse, 2 five-position range switches, 2 "delay-adjust" pots, and 4 neon lamps. Signal and power plugs and four tip jacks are mounted on the rear panel. The delay of each channel is continuously adjustable from 1 to 10,000 μsec in four overlapping ranges. The following specifications apply: minimum input pulse, +30 v, 0.5 μsec wide; output pulse, +180 v, 2 μsec wide into 50 Ω; delay range, 0.08 μsec fixed delay and 1 to 10,000 μsec in 4 ranges; Rep rate, single pulse to 20 pps; Jitter, 0.01% or 1 shake, whichever is greater; delay shift due to line voltage shift, 0.03%/v; a-c input power, 105 to 125 v/a-c, 1.4 amp@117 v/a-c. The delay chassis is used with a pulse generator and an oscilloscope. (For details, see TID-4100). (M.C.G.)

640 TIME CONSTANT CONTROL SYSTEM FOR X-RAY ANALYZERS AND GAGES. Culbertson, Robert J. (to General Electric Co.). U. S. Patent 3,196,272. July 20, 1965. Filed Sept 5, 1962.

A time-constant control system is provided for instruments for determining the characteristics of a test sample, such as thickness, quantity and identity of the chemical elements of which the sample is composed, or its atomic lattice structure, and is particularly useful in instruments that excite a sample with electrons. Provision is made for changing the time constant of the instrument during the course of processing a particular sample so that earlier readout and increasingly better provision will be permitted. Electronic modification of the circuits facilitates the standardization of the instrument. (B.L.M.)

641 DELAYED WARM-UP FILAMENT POWER SUPPLY FOR MASS SPECTROMETER WITH EMISSION CURRENT REGULATION. Watters, Robert L. (to General Electric Co.). U. S. Patent 3,197,634. July 27, 1965. Filed Oct. 30, 1963.

An emission current regulated power supply for the filament of a mass spectrometer delays the application of full power to the filament for a predetermined time during which a gradual increase in power occurs to prolong the filament life. The time delay is accomplished with a source of gradually increasing voltage that is used to supplement the electron collector input signal to the control element of the filament power supply. After a predetermined time lapse, the auxiliary voltage stabilizes at a constant value, in order to minimize any disturbance in the emission current control function, and more particularly to avoid adversely affecting the rapid response time of the emission current control. (B.L.M.)

642 ATOMIC COLLISION INFLUENCED GASEOUS ^{3}He QUANTUM RESONANCE MAGNETOMETER APPARATUS. Colegrove, Forrest D. Jr.; Schearer, Laird D.; Walters, Geoffrey K. (to Texas Instruments Inc.). U. S. Patent 3,206,671. Sept. 14, 1965. Filed Apr. 9, 1962.

A He-3 gas magnetometer is provided that is capable of measuring the absolute magnitude of an ambient magnetic field, and any recalibration of the system is eliminated when the orientation of the magnetometer is changed relative to the direction of the ambient magnetic field. The apparatus consists of means for containing in a confined zone the He-3 gas having atoms in the 1^1S_0 ground state and the 2^3S_1 metastable state capable of undergoing collisions in the zone. Means are provided for exciting the atoms from the ground state to the metastable state and for polarizing the atoms in the metastable state in the zone to provide by collisions polarization of the ground state atoms. (B.L.M.)

643 METHOD FOR MEASURING LOW DENSITY ATMOSPHERES. Schumacher, Wilhelm W. B. (Ontario Research Foundation). U. S. Patent 3,207,895. Sept. 21, 1965. Filed Apr. 5, 1961.

A method and apparatus for measuring the density of low density atmospheres is based on the principle of detecting single charged particles. A beam of charged particles is directed along a path through an atmosphere of at least substantially uniform density from a source towards a detector beyond the beam observation area. The detector is shielded from unscattered particles and detects and counts scattered particles scattered from the beam at the beam observation area at an acute forward angle relative to the direction of travel of the beam. The number of single scattered particles counted is related to the atmospheric density. (B.L.M.)

644 UNILINEAR DISPLACEMENT MEASURING APPARATUS. Herndon, Howard V. (to U. S. Atomic Energy Commission). U. S. Patent 3,210,852. Oct. 12, 1965.

An apparatus for measuring a small displacement is described. In the apparatus, a rotating shaft reciprocates a part, the part in reciprocating angularly shifts to rotate and move axially one of a set of threaded members, another of the set is moved axially an amount equal to the displacement to be measured, and a counter indicates the rotations of the shaft as a measure of the said displacement. Significant features of the invention are that the reciprocating part reciprocates many times to produce a single rotation of the one threaded member and that the latter has many times the axial movement of the other threaded member. (AEC)

645 MICROWAVE WAVEGUIDE COUPLING SEAL. Skarpaas, K. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,035. Oct. 12, 1965.

A coupling device for joining sections of microwave waveguides in vacuum-tight relation and to maintain good microwave transmission therethrough is discussed. The coupling includes a flanged joint sealed by a thin copper jacket in which one flange surface includes a raised portion bearing across thin deformable copper gasket adjacent the waveguide passages with respect to a depressed surface on the other flanged joint providing a good electrical contact. Sealing of the joint is effected by integral copper gasket portions disposed between slanted mating annular seal surfaces of the flanges which are indented and deformed to provide a high vacuum seal. Peripheral flange areas provide a stop to avoid excessive deformation of the seal. (AEC)

Radiation Detection

Refer also to abstracts 391, 1293, 1357, 1362, and 1418.

646 (AD-614432) A SOLID STATE NUCLEAR DETECTOR. Final Report. Wilcox, G. E. (Naval Air Development Center, Johnsville, Pa.). Mar. 23, 1965. 18p. (NADC-EL-6504). CFSTI $1.00 cy, $0.50 mn.

A study was undertaken to determine the applicability of photoconductive (PC) and electroluminescent (EL) materials to a scintillation system for the detection and measurement of nuclear radiation. Efforts to amplify individual light flashes from scintillation phosphors by using ELPC sandwiches as light amplifiers met with little success because of the slow response time characteristic of the photoconductor. This characteristic, however, made the PC element a valuable integrating device, and a simple, reliable, and economical solid state ratemeter was developed and evaluated for the measurement of alpha, beta, gamma, and neutron dose rates over a wide range of operation. In view of the universal need for a versatile, low-cost radiation dose ratemeter, it is recommended that the results of this effort be made available to potential users. (auth)

647 (AERE-M-1631) REDUCTION OF THE SULPHUR DOSE THRESHOLD IN THE A.E.R.E. CRITICALITY DOSIMETER. Boot, S. J. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 8p. Dep.; BIS $0.30; HMSO 1s. 9d.

A method is described of measuring a lower limit of fast neutron dose of 0.21 rad for accident conditions using the $^{32}S(n,p)^{32}P$ reaction in a 1.65-g sulfur disk. The disk is completely ashed in an aluminum dish 0.001 in. thick whose sides are then folded down to form a flat aluminum disk source. The phosphorus-32 β activity is measured by a Geiger-Müller counter having an anti-coincidence shield. (auth)

648 (AERE-R-4960) THE SLOW NEUTRON CALIBRATION OF FILM AND OTHER GAMMA DOSIMETERS. Boot, S. J.; Dennis, J. A. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 17p. Dep.; BIS $0.60; HMSO 3s. 0d.

The slow neutron calibration of the film dosimeter used at A.E.R.E. Harwell was determined for exposures in free air and on the surface of a tissue-equivalent chest phantom. The slow neutron and gamma flux determinations associated with the film measurements are described in detail. Equations are derived from which neutron and gamma doses may be found from film densities and the errors involved are given. Slow neutron and gamma flux reflection caused by the phantom is discussed with reference to results of depth dose calculations. (auth)

649 (BNL-9543) RECENT TRENDS IN PARTICLE DETECTION AT HIGH ENERGIES. Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 20p. (CONF-650923-12). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 5th International Conference on High Energy Accelerators, Frascati, Italy.

Possible future developments in several high energy particle detection devices are discussed. The devices discussed are bubble chambers, Cherenkov counters, scintillation hodoscope and on-line computer methods, and spark chambers and wire chambers. The time-of-flight method is also discussed. (M.O.W.)

650 (COO-614-37, Sect. 2C) RESOLUTION OF MULTI-EVENT AMBIGUITIES IN WIRE SPARK CHAMBERS BY MEANS OF EXTRA WIRE. Miller, R. H. (Chicago Univ., Ill. Inst. for Computer Research). 18p.

The ambiguity resulting from two or more events in a wire spark chamber was previously pointed out. It was also asserted that the ambiguity can be resolved by using additional sets of wires to produce redundant information. The processes involved in actually working out the resolution are discussed. (M.O.W.)

651 (EGG-1183-2055) REJECTION OF NaI PULSE PILE-UP IN LINAC BREMSSTRAHLUNG MEASUREMENTS. McGuire, R. L.; Sandifer, C. W. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). [1964]. Contract AT(29-1)-1183. 19p. (CONF-651001-3). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From IEEE Nuclear Science Symposium, San Francisco.

A pulse pile-up rejection system was developed and used successfully with a NaI gamma spectrometer to measure the bremsstrahlung spectral distribution from a 0.2-radiation-length gold-tungsten target bombarded by high energy electrons from a pulsed electron linear accelerator. The system utilizes a double differentiation technique to reject those scintillation events where more than one gamma ray is detected during a single linac pulse. The pulse pile-up rejection circuit was used effectively over a gamma energy range of 0.25 to 21 Mev and increased data collection speed by about a factor of 20. The performance of the system agrees with theoretical predictions calculated on the basis of Poisson statistics. Gamma spectral distributions measured with the system at the EG&G linac are presented to demonstrate utilization of the system. (auth)

652 (INR-647/I-A,VI/PH) OBSERVATION OF FISSION EVENTS IN MICA SANDWICHES. Cieslak, E.; Piekarz, J.; Zakrzewski, J.; Dakowski, M.; Piekarz, H.; Sowinski, M. (Institute of Nuclear Research, Warsaw (Poland)). July 1965. 22p. Dep.

A method is described for preparing mica sandwiches that could be used in experiments to study the cross sections of heavy nuclei to high-energy fission. Mica sandwiches with natural uranium, prepared by this method, are exposed to thermal neutrons from a reactor. After appropriate chemical treatment, fission fragment tracks are observed under an optical microscope The average efficiency of observation of fission events in such sandwiches is estimated using semiconductor detectors. (auth)

653 (LAL-1143) A CURRENT SPARK CHAMBER USED AS A SEVERAL HUNDRED CHANNEL LADDER COUNTER. Jeanjean, J.; Lefrancois, J.; Perez-Y-Jorba, J. (Laboratoire de l'Accelerateur Lineaire, Univ. de Paris, Orsay (France)). Sept. 1965. 36p. Dep. mn.

A spark chamber where a current signal is used to measure the position of the spark was developed for the purpose of its use as a several hundred channel ladder counter associated with a magnetic spectrometer. The main characteristics of the chamber were first determined with a β ray source and with cosmic rays. An investigation of the linearity, the resolution of the instrument, and the accuracy on the localization of the sparks is presented. The overall characteristics of the system were then checked on a magnetic spectrometer by studying the scattering of high energy electrons on ^{9}Be. (auth)

654 (NP-15466) RASCHET EFFEKTIVNOSTI RADIATORA PROTONOV OTDACHI V POLE IZOTROPNOGO IZLUCHENIYA NEITRONOV. (Computing the Effectiveness of a Recoil Proton Radiator in a Field of Isotropic Neutron Radiation). Report No. 321. Stanislav, Pshona (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1965. 8p. Dep. mn.

An expression is derived for the effectiveness of a radiator of recoil protons in a field of isotropic neutron radiation, for any given energy discrimination. The results of calculations for neutron energies of 0.2 to 20 Mev are presented. (auth)

655 (PHS-999-RH-15) QUALITY CONTROL OF RADIOACTIVITY-COUNTING SYSTEMS. Kolde, H. E. (Public Health Service, Washington, D. C. Div. of Radiological Health). Aug. 1965. 18p. Public Health Service Free.

Techniques for obtaining satisfactory performance from radioactivity-counting systems are described. Acceptable performance is maintained by routine tests of background and standards combined with the application of statistical criteria of acceptability. The use of control charts in conjunction with test data is recommended to facilitate determination of satisfactory instrument and sample measurements. Corrective adjustments are made when necessary to assure continuity of reproducible results, which is particularly important for long-term studies. Methods of chart application and interpretations of plot patterns are outlined. Requirements for the design of counting laboratories, suitable performance standards, and associated control measures are also discussed. (auth)

656 THERMOLUMINESCENT DOSIMETRY. Spurny, Z. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). At. Energy Rev., 3: 61-115(1965).

An analysis of literature on thermoluminescent dosimetry up to the Spring of 1965 is presented. The historical background and the necessary theory are given. Then the principles of the method are explained, and the attempts to realize a personnel dosimeter are briefly reviewed. Types of phosphors, dose and dose-rate responses, precision and linearity obtainable, time stability of dosimeter response, temperature influence and stability, energy dependence and sensitivity to different kinds of radiation (including neutrons) are analyzed. Next, certain other applications of radiothermoluminescence phenomenon are mentioned, and a comparison of the main solid-state detectors is provided. Finally, the possible trends of development and utilization of thermoluminescent dosimeters are described. 275 references. (auth)

657 A.C. RESPONSE OF A SATURATED IONISATION CHAMBER. Thomas, G. C. (Univ. of Southampton, Eng.). Electron. Lett., 1: 199-200(Sept. 1965).

The small-signal impedance between the electrodes of an ionization chamber is studied over a range of frequency and ionization. The impedance is approximately that of an equivalent circuit which has one RC combination for each group of ions in the chamber. More accurate formulas are given. Experimental results support the theory. (auth)

658 DEVELOPMENT OF ENERGY-INDEPENDENT FILM BADGES WITH MULTI-ELEMENT FILTERS. Storm, Ellery; Shlaer, Simon (Los Alamos Scientific Lab., N. Mex.). Health Phys., 11: 1127-44(Nov. 1965). (LA-DC-6479; LA-DC-6479(Rev.)).

The development of two film badges with constant responses per R over a wide range of x- and gamma-ray energies is described. The lead-lattice film badge contains a multi-element filter (0.013 g/cm^2 gadolinium, 0.085 g/cm^2 erbium, 0.100 g/cm^2 tantalum, 0.138 g/cm^2 gold, and 0.081 g/cm^2 bismuth) and a copper fluorescent absorber having a thickness variable with the film type. The response of Du Pont 502, 508, and 555; Eastman Type II; and Ilford PM-1 films in this badge is flat within 30 per cent from 50 to 1250 kev. The badge is directionally

dependent, and the density under the filter is uniform. The lead-frame film badge contains a multi-element filter (0.128 g/cm^2 gadolinium, 0.129 g/cm^2 erbium, 0.114 g/cm^2 tantalum, 0.117 g/cm^2 gold, and 0.074 g/cm^2 bismuth) and a 0.02 in.-thick copper fluorescent absorber. The response of the films listed is flat within 30 per cent from 40 to 1250 kev. The badge is directionally independent within 30 per cent, but the density under the filter at low energies is non-uniform, the edges being darker than the central area. The badges were modified to permit the evaluation of thermal neutron and beta-radiation exposures. A method was devised for measuring thermal neutrons using two multi-element filters having similar photon responses. (auth)

659 A SHADOW SHIELD WHOLE-BODY COUNTER. Palmer, H. E.; Roesch, W. C. (General Electric Co., Richland, Wash.). Health Phys., 11: 1213-19(Nov. 1965). (HW-SA-3686).

A whole-body counter is discussed that combines shadow shielding with (integral or differential) scanning; weighs only 5 tons; has a background as low as an iron-room counter; has little variation in sensitivity for different size people; and has only slightly less sensitivity than an iron-room counter. The light weight of the counter was exploited by placing one in a truck for use in a radiation protection program and by transporting it by air for use in a study of radioactivity in Alaskan Eskimos. (auth)

660 THE HANFORD MOBILE WHOLE-BODY COUNTER. Brady, D. N.; Swanberg, F. Jr. (Battelle Memorial Inst., Richland, Wash.). Health Phys., 11: 1221-4(Nov. 1965). (HW-SA-3559).

The Hanford Mobile Whole-Body Counter is a self-contained whole-body counter laboratory installed in a semi-trailer. A modification of the shadow shield concept of Roesch and Palmer provides a compact, relatively light-weight whole-body counter easily transportable in a truck or semitrailer. The mobility of this new laboratory provides versatile capabilities for measuring internally deposited gamma-ray emitting radionuclides in human beings. It was designed to supplement existing facilities of the Hanford Laboratories to permit economical examination of employees near their work locations. Additionally, it provides improved capability for assistance should radiological emergencies occur. Design, construction, and initial operation of the new whole-body counter system are described. (auth)

661 METHOD FOR BETA-RAY DOSE RATE DETERMINATIONS BY MEANS OF AN END-WINDOW COUNTER TUBE AND OF ABSORBERS. Schwaar, L. (VEB Vakutronik WIB, Dresden). Kernenergie, 8: 423-5(July 1965). (In German).

A method is described for the determination of beta ray dose rates by simple means. An adequately shaped absorber is arranged on the window of an end-window counter tube, and the counting rate is measured both with and without absorber. The difference of the counting rates then is proportional to the beta dose rate. The accuracy of the measurements may be sufficient for routine studies. (auth)

662 TEST MEASUREMENTS BY MEANS OF A SCINTISCANNER CONTRAST AMPLIFIER. Berger, K.-H. (VEB Vakutronik WIB, Dresden). Kernenergie, 8: 430-6 (July 1965). (In German).

The efficiency of an amplifying circuit for scintiscanner devices was determined by carrying out phantom measurements. (auth)

663 SOME NOTES ON SCINTILLATION COUNTING DEVICES FOR BETA-RAY DOSIMETRY USING THIN PLASTIC SCINTILLATORS. Nentwig, G. (VEB Vakutronik WIB, Dresden). Kernenergie, 8: 481-4(Aug. 1965). (In German).

A study of the counting response of scintillation counting devices using thin plastic scintillators when irradiated with beta particles of different energies with special relation to the discriminating energy as well as knowing the dose deposed in tissue per particle as a function of energy showed that utilizing a plastic scintillator of a surface density of about 10 mg/cm^2 in connection with a discriminating level of about 50 kev makes it possible to measure the beta dose or dose rate early independently of the maximum energy of conventional beta emitters in the range of about 150 kev to at least 2.5 Mev. (auth)

664 LITHIUM-DRIFTED DETECTORS FOR BETA- AND GAMMA-SPECTROMETRY. Chwaszczewska, Janina; Dakowski, Miroslaw; Przyborski, Wincenty; Sowinski, Mieczyslaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 10: 251-4(1965).

The performance of lithium-drifted β and γ-semiconductor spectrometers is described. Lithium-drifted silicon diodes prepared on the basis of the Pell method made possible the construction of β-particle detectors with thin window and very good characteristics. The depletion layer thickness is 2.8 mm and active area—160 mm^2. For gamma spectroscopy, the lithium-drifting process was carried out on p-type gallium-doped germanium samples of 5Ω/cm resistivity and about 100 μsec life time minority carriers. A compensated region 1.5 mm thick was obtained. Beta and gamma spectra for ^{207}Bi are illustrated. (P.C.H.)

665 GOLD–SILICON SURFACE-BARRIER BETA-SPECTROMETER WITH MULTI-GUARD-RING. Roman, Jerzy (Central Lab. for Radiological Protection, Warsaw); Chwaszczewska, Janina; Dabrowski, Andrzej. Nukleonika, 10: 255-7(1965).

Gold-silicon surface-barrier detectors with very low leakage-current, good energy resolution at high reverse bias, and high stability in long-term operation and containing multiple-guard-rings were constructed. The detectors were tested up to 1,500 v reverse bias at room temperature without any sign of breakdown. A long-term test proved that the detectors operate for several weeks in air and in vacuum without any visible changes in their characteristics and any measurable increase of noise level. The detectors were used as high resolution beta spectrometers. (P.C.H.)

666 ABSOLUTE MEASUREMENTS OF RADIOACTIVITY WITH 4π COUNTER. Lada, Witold; Radoszewski, Tomasz. Nukleonika, 10: 277-85(1965).

The results of investigations on 4π proportional counter application for absolute measurements of radioactivity of β and β-γ emitters are reported. Particular stress is made on defining the corrections for absorption in the source holder and for self-absorption in the source, as well as on the errors due to the dead space in the counter. The counter was checked by measurements of standard solutions. (auth)

667 PHOTOGRAPHIC DETECTION OF FAST NEUTRONS: APPLICATION TO NEUTRON RADIOGRAPHY. Tochilin, E. (Naval Radiological Defense Lab., San Francisco). Phys. Med. Biol., 10: 477-90(1965).

The relative advantages of different methods for producing fast neutron radiographs are considered. Maximum photographic response was obtained with organic scintillators used as intensifying screens in conjunction with film. Neutron radiographs at two different energies were obtained with test blocks made of Al, Cu, Pb, and plastic. Exposures were made with film-screen systems and with film alone. The test blocks were exposed intact and with varying thicknesses of plastic and Pb placed in front of them. Radiographs taken with the plastic Al and Cu blocks were inferior to those taken with Pb. Radiographic contrast was found to be severely limited by neutron scattering with the subsequent build-up of gamma rays from thermal neutron capture in the material. The technique appears to be limited to materials less than several inches thick. (auth)

668 PROPOSAL FOR A NEW TYPE OF A SCINTILLATION GAMMA CAMERA. Kalish, Y. (Rogoff Medical Research Inst., Beilinson Hospital, Israel). Phys. Med. Biol., 10: 525-8(1965).

A new type scintillation gamma camera is described. The camera is to be composed of a grid collimator, two image intensifier tubes, an image orthicon, a multi-channel analyzer and some other electronic circuits. A field size of 100 in.^{2} will be used and a resolution power of 3 mm is expected. (auth)

669 THERMOLUMINESCENT PHOSPHORS: VARIATION OF QUALITY RESPONSE WITH DOSE. Naylor, G. P. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol., 10: 564-5(1965).

Samples of Conrad N phosphor in polythene tubes were compared with Baldwin Sub-Standard Ionization Chambers for a range of doses from 50 to 800 Rads and radiations of effective energies from 30 kev to 1.5 Mev. It was found that for the phosphor and dose range mentioned ^{60}Co gamma rays are twice as effective in forming new traps as 130-kev x rays. (P.C.H.)

670 ON GREENING'S TREATMENT OF SATURATION CHARACTERISTICS OF PARALLEL-PLATE IONIZATION CHAMBERS. Katoh, Kazuaki (Japan Atomic Energy Research Inst., Tokyo). Phys. Med. Biol., 10: 565-6(1965).

Discrepancies in Greening's equations (Greening, J. R., Phys. Med Biol., 9: 143(1964)) for saturation characteristics of parallel-plate ionization chambers are pointed out. The definition of m as used in the equations is also discussed. (P.C.H.)

671 A NEW METHOD OF OBTAINING ISODOSE CURVES USING FILM DOSIMETRY. Lescrenier, C. (Yale Univ., New Haven); Stacey, A. J.; Jones, C. H. Phys. Med. Biol., 10: 567-9(1965).

A method was developed which produces isodensity shapes from exposed film dosimeters within a matter of seconds. The method consists of taking photocopies of the film by a diffusion system. The essential steps are outlined. The method considerably simplifies the use of film dosimetry and provides a rapid method of evaluating its potentialities. (P.C.H.)

672 UNIVERSAL SPECTROMETER 1, COMPONENTS (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE–1248).

95 drawings.

The polarization spectrometer described will be used at the High Flux Beam Research Reactor (HFBRR). This reactor with a compact core operates at high power density with a total flux of about 1.6×10^{15} n/cm^{2}sec. The spectrometer will be used in low-temperature neutron alignment measurements using polarized neutrons. The crystal may be positioned in 6 degrees of freedom to direct a precisely monochromated beam of polarized neutrons through a guide field to a target sample held at temperatures close to 0.1°K. All motions are remotely actuated and recorded. Included are a polarized beam monochromator, crystal goniometer, angle divider, and shield. (For Details, See TID-4100) (M.C.G.)

673 IONIZATION CHAMBER /Q-2215/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1227).

1 drawing.

The 50-cc spherical ionization chamber described is used in making γ measurements in the shielding program at the Tower Shielding Facility. The ionization chamber uses less graphite than the previous model since it is not used in water. (For Details, See TID-4100) (M.C.G.)

674 FLOW-PROPORTIONAL COUNTER /Q-2275/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1286).

2 drawings.

The chamber described is used for α or β proportional counting. The sample is counted without an absorbing window between the sample and the counter. This Borkowski-type instrument is an improved, simplified design of an earlier model. It costs less to fabricate and has a sliding sample holder, which seals the chamber gas volume. The chamber body is of aluminum as is the slide. (For Details, See TID-4100) (M.C.G.)

675 NEUTRON DIFFRACTION SPECTROMETER–MA (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1239).

584 drawings.

The automatic, double-crystal neutron diffractometer described is used for crystal and magnetic structure analyses at temperatures from 2 to ~2000°K, with a magnetic field of up to 18 kGauss for a 1.4-in. gap. It is primarily intended for study of thermal-neutron elastic scattering by polycrystalline and single-crystal substances. Limited studies of the inelastic scattering, total and related cross sections, and small-angle scattering can also be accomplished. Nonpolarized beams of neutrons are used. (For Details, See TID-4100) (M.C.G.)

676 CALCULATED GAMMA RAY PHOTOFRACTIONS FOR WELL-TYPE SCINTILLATION DETECTORS. Snyder, B. J.; Knoll, G. F. (Univ. of Michigan, Ann Arbor). 14p. (CONF-650602–67). Gmelin, AED-CONF-64-219-137.

From American Nuclear Society, 11th Annual Meeting, Gatlinburg, Tenn.

Methods of calculation and some results for photofractions of well-type scintillation crystals are presented. Data for two commonly used crystals are tabulated. Calculations of photofractions for well-type crystals are discussed; these, due to the nearly 4π geometry, are frequently preferred over solid crystals for low level counting. The solid crystal photofractions were also calculated. Monte Carlo techniques were used to determine the probability of total absorption, including secondary particles for interacting gammas. A more rigorous treatment of secondary electrons and generated bremsstrahlung photons may account for the improved results obtained. A comparison between photofractions calculated for solid and well-type crystals is given. This shows that fairly close values were obtained for both crystals. Photofractions for CsI(Tl) and CaI_2(Eu) scintillation crystals relative to NaI(Tl) are also given. (J.F.P.)

677 IMPROVEMENTS IN SCINTILLATORS FOR COUNTING α PARTICLES. (to Philips Electronic and Associated Industries Limited). British Patent 1,003,220. Sept. 2, 1965. Priority date Dec. 18, 1961, France.

A layered scintillator for counting alpha particles has a thickness of the order of 10μ. The scintillator is made by layering, by evaporation of a solvent, translucent plastic material. A fluorescent inorganic powder is included in the solvent applied to form the surface layer, which is faced by at least one layer of a substance that passes alpha particles but serves as a light barrier. (B.L.M.)

678 INSTRUMENT FOR THE MEASUREMENT OF THE RADIATION INTENSITY. (to The Bendix Corp.). German Patent 1,194,068. June 3, 1965. Priority Mar. 30, 1960, United States.

The instrument comprises a string electrometer disposed within the ionization volume of an ionization chamber. The electrometer consists of a rigid, semi-circular curved support and a string which is arranged parallel to the support and the ends of which are attached to the ends of the support. The distance between the apex of the string and the support is a function of the dose rate. (Gmelin Inst.)

679 MONITORING AND WARNING APPARATUS FOR CONTAMINATIONS EFFECTED BY ALPHA AND BETA RAYS. Brown, James Robert; Sharpe, Jack (to Electric and Musical Industries Ltd.). German Patent 1,194,069. June 3, 1965. Priority date Oct. 6, 1959, Great Britain.

The monitor comprises a common detector for both types of radiation followed by a discriminator and two trigger circuits delivering pulses according to the alpha or the sum of alpha and beta intensities respectively. The intensities of the beta particles may be registered by subtraction. The trigger circuits are connected to circuit arrangements which provide a common loudspeaker with sound signals characteristic of alpha or beta particles respectively. (Gmelin Inst.)

680 METHOD FOR THE PREPARATION OF A PULSE-PRODUCING MINIATURE IONIZATION CHAMBER FOR USE AS A NEUTRON DETECTOR. Query, Marcel (to Commissariat a l'Energie Atomique). German Patent 1,195,415. June, 24, 1965. Priority date Jan. 7, 1960, France.

The fission chamber comprises an outer electrode surrounding an inner electrode which is coated with fissionable

material. The method for the fabrication of the chamber comprises the steps of coating the inner electrode with fissionable material and of inserting at the same time an insulated, sealed electrical lead-in into one opening of the cylindrical outer electrode, of introducing the inner electrode into the outer electrode and attaching it to the lead-in, of putting the chamber into a vacuum vessel, of filling the vacuum vessel with an inert gas containing mainly Ar, and of sealing the other end of the outer electrode in a known manner by welding a closure together with the outer electrode. (Gmelin Inst.)

681 APPARATUS FOR DETERMINATION OF THE EFFECTIVE ENERGY OF FAST NEUTRONS. Nachtigall, Dieter (to Kernforschungsanlage Juelich). German Patent 1,195,416. June 24, 1965. Filed Dec. 6, 1962.

The threshold detector consists of a cylindrical detector surrounded by a moderator and a removable threshold foil between the moderator and the detector. (Gmelin Inst.)

682 DEVICE FOR THE CONTINUOUS MEASUREMENT AND MONITORING OF THE RADIATION INTENSITY OF RADIOACTIVE SUBSTANCES SUSPENDED IN AIR, GASES, OR VAPORS. Prochazka, Rudolf. German Patent 1,199,894. Sept. 2, 1965. Priority date Oct. 5, 1962, Austria.

The device comprises a tube through which the gaseous medium loaded with the radioactive suspended substances is circulated, and deflector means or a cylindrical vortex chamber at the inlet of the tube which impart a rotational movement to the mixture of gas and solid particles driving the solid particles outward toward the periphery of the tube. The wall of the tube is either constructed in the shape of one or more counter windows or scintillation heads or is covered with a radiographic film on the inside. (Gmelin Inst.)

683 CIRCUIT ARRANGEMENT FOR PORTABLE RADIATION DETECTION INSTRUMENTS, ESPECIALLY DOSE RATE METERS. Loseries, Hans-George; Koch, Edgar (to Reichert-Elektronik G.m.b.H. and Co. K. G.). German Patent 1,200,446. Sept. 9, 1965. Filed Mar. 11, 1963.

A circuit arrangment for portable dose rate meters is given which comprise installed counters and a plug-in device provided with a plurality of contact studs for the connection of probe counters. A meter switch connects the high voltage source with the contact studs of the plug-in device part of which are connected to the installed counters. As long as a suited blind plug is inserted into the plug-in device the installed counters are connected to the high voltage source. For the disconnection of the installed counters and the connection of probe counters the blind plug is removed and a probe plug connected to one or more probe counters is inserted into the plug-in device. (Gmelin Inst.)

684 INTEGRATED NEUTRON FLUX INDICATOR. Kuether, Frederick W. (to Honeywell Inc.). U. S. Patent 3,201,589. Aug. 17, 1965. Filed Dec. 26, 1961.

An integrated neutron flux indicating means consists of a pair of dissimilar metals forming a thermocouple, means for maintaining a constant temperature differential between the hot and cold junctions of the thermocouple, and means associated with the thermocouple to measure an emf. One member of the thermocouple is composed essentially of ^{54}Fe and undergoes transmutation upon exposure to the neutron radiation; while the second member is composed essentially of ^{56}Fe, which undergoes a limited transmutation. The transmutations result in a change in the emf output of the thermocouple. (B.L.M.)

685 BETA AND GAMMA MEASURING APPARATUS FOR FLUIDS. Christianson, Charles (to U. S. Navy). U. S. Patent 3,202,819. Aug. 24, 1965. Filed May 8, 1963.

An apparatus is provided for sampling radioactive fluids, particularly gases, identifying and determining the activity of the radioactive constitutents in the sample. The apparatus for detecting the beta and gamma radiation consists of a housing including a chamber with the housing wall being opaque to beta radiation and energy in the visible spectrum. A window in the housing wall is transparent to beta radiation. A beta-responsive phosphor is contained in the chamber in such a position that its scintillations are visible through the window. A gamma-responsive phosphor is secured to the exterior of the housing wall portion opaque to beta radiation. Means are provided for filling the chamber with a fluid sample. (B.L.M.)

686 ALPHA PARTICLE COUNTER AND INTEGRATING CIRCUIT ARRANGEMENT. Ludlum, Donald G. (to Eberline Instrument Corp.). U. S. Patent 3,204,099. Aug. 31, 1965. Filed May 10, 1961.

A monitoring device is provided that for the time of measurement will integrate the total quantity of particles emanating from an individual, as his hand, to give an indication of the contamination. The monitor includes an electrical circuit containing a trigger for receiving signals from a probe and converting them to pulses of equal magnitude, a meter, and circuit connections between the trigger and the meter to advance the reading on the meter in proportion to the number of pulses delivered to the trigger. An alarm signal is operated by the meter when it reaches a predetermined value. Indication of a safe limit of the count for a given length of time is provided, and in the event of an incomplete count a mechanism provides for resetting the counter mechanism and meter to zero upon removal of the hand of the individual from the device. (B.L.M.)

687 RADIATION POSITION DETECTOR. Sandborg, Alan O. (to Nuclear Diodes, Inc.). U. S. Patent 3,207,902. Sept. 21, 1965. Filed June 20, 1963.

An improved surface barrier p-n junction particle detector is described that can be made to identify the position in which a particle strikes the detection surface and to identify the energy imparted by the impinging particle. A first electrode is positioned on one surface of the semiconductor material and a pair of second electrodes are spaced at opposite edges of the opposite surface. Biasing means are provided between the first and second electrodes. When a radiation particle penetrates the p-n junction, the charge collected at the first electrode corresponds to the sum of the charge collected at the second electrodes; and the proportion of the charge collected at one pair of electrodes to the sum of the charge collected at both of the second electrodes is directly related to the position of impingement of the particles between the second electrodes. (B.L.M.)

688 SUPERATMOSPHERIC PRESSURE IONIZATION CHAMBER FOR DETECTION OF RADIANT ENERGY. Anton, Nicholas. U. S. Patent 3,207,938. Sept. 21, 1965. Filed Oct. 31, 1961.

A radiant energy detector responsive to both gamma and beta radiation consists of a casing containing a volume of ionizable gas under super-atmospheric pressure, having a wall forming a cathode electrode, and an anode electrode within the casing. The wall is formed of a material responsive to gamma radiation to produce high energy electrons and has multiple apertures to permit passage of beta radiation. The casing is lined with a metal foil lining readily permeable to beta radiation and extending over the apertures. (B.L.M.)

689 SIMULATED RADIATION DETECTOR. Filipov, Alexander M. (to United States of America). U. S. Patent 3,208,159. Sept. 28, 1965. Filed Aug. 26, 1963.

An optical system is provided for use with a simulated radioactive radiation meter. The optical system comprises a lens that is used to focus a primary source of radiation having a first frequency on a contaminant and refracting the resulting emanating second radiation by the lens toward several reflecting surfaces that are located away from the optical axis of the lens. One of these reflecting surfaces is adapted to be moved toward the other to vary the effective range of the optical system. These reflecting surfaces in turn direct the incident refracted secondary radiation towards a detecting means that is capable of detecting the secondary radiation. (B.L.M.)

690 FLUID FLOW RADIOACTIVITY MEASURING APPARATUS AND SAMPLING MEANS. McGrath, Robert G. (to Westinghouse Electric Corp.). U. S. Patent

3,209,145. Sept. 28, 1965. Filed Apr. 24, 1961.

A radiation measuring arrangement is provided for use with flowing radioactive fluids or other materials, which integrates the specific activity of the fluid and its flow rate to obtain a direct indication of the total activity being transported by the fluid. The arrangement is a combination of a manometer and a radiation detector. A volume of the manometer fluid is displaced in an amount proportional to the flow of the fluid in the conduit, and a continuous sample of the flowing fluid is permitted to fill the volume of the reservoir from which the manometer fluid is displaced. A radiation detector placed in the vicinity of the sample detects an amount of radiation that is proportional to the product of the flow rate and the specific radioactivity of the flowing fluid. The apparatus is applicable to flowing streams of gases, liquids, or any suitable vehicle containing particulate material, such as slurries, or dust in gases. (B.L.M.)

691 RADIATION DETECTOR AND DISCRIMINATOR UTILIZING A SEMI-CONDUCTOR SOLID STATE DETECTOR. **Allenden, Dennis; Boddy, Keith; Freck, David Vernon; Hunt, Stanley Ernest (to Associated Electrical Industries Ltd.). U. S. Patent 3,209,151. Sept. 28, 1965. Priority date Sept. 18, 1961, Great Britain.**

An apparatus for detecting radiation in gases includes a semiconductor solid state detector, means for exposing a strip of material to the radiation, means for moving the irradiated strip into operative relation with the detector, means for producing an electric pulse output from the detector, and means for analyzing the pulse output to determine the nature of the radiation. The analyzing means is made up of a number of filters each passing a pulse of a different pulse height band, selector switching means for rendering a required filter operative, and means for varying the length of time during which the strip of material is exposed to the radiation. The apparatus is particularly applicable to detecting Pu-239, U-235, and U-238 in the air. (B.L.M.)

Radiation Effects

692 (NASA-CR-312) STUDY ON THE ELECTRON IRRADIATION EFFECTS ON CAPACITOR-TYPE MICROMETEOROID DETECTORS. Monteith, L. K. (Research Triangle Inst., Durham, N. C.). Oct. 1965. Contract NAS 1-3892. 97p. CFSTI $3.00 cy, $0.75 mn.

Electron irradiation of capacitor structures consisting of polyethylene terephthalate films with thin aluminum electrodes is found to result in a trapped charge distribution in the dielectric region. The decay of the trapped irradiation electrons is shown to be consistent with a nonretrapping release model based upon a density of traps that is uniform with respect to energy measured from the conduction band. A saturation effect for irradiation electron trapping is also noted. Irradiation of the capacitor structure using a beta ^{147}Pm source results in spontaneous discharge. The pulse is an exponential decay from its maximum amplitude, as predicted by theoretical considerations. The origin of the breakdown is investigated. All observations lead to the conclusion that breakdown initiated by the electrical field resulting from the trapping of irradiation electrons primarily occurs at defects in the polyethylene terephthalate film, and in most instances does not liberate all the trapped charge. (auth)

693 (NP-15172) CONTRIBUTION A L'ETUDE DU BRUIT DE GENERATION-RECOMBINATION DANS UN DETECTEUR DE RAYONNEMENTS NUCLEAIRES A BARRIERE DE SURFACE (Theses). (Contribution to the Study of Generation-Recombination Noise in a Surface-Barrier Nuclear Radiation Detector (thesis)). Sau, Jacques (Lyon Univ. (France). Faculte des Sciences). May 1965. 60p. Dep. mn.

The noise of Si surface-barrier detectors (the distribution according to the frequency of the mean power and the Fourier transformation of this distribution called the autocorrelation function) was measured. A theoretical model was constructed to interpret the results obtained. The formation of a potential barrier at the surface of a semiconductor is first described. Various characteristics of time-dependent functions are reviewed. The results are given and interpreted using a model based on the generation and disappearance of charge carriers intervening in the electric conduction. (J.S.R.)

694 MEASUREMENT OF SMALL CHANGES IN RESISTANCE IN THE ENVIRONMENT OF A NUCLEAR REACTOR. **Ramsay, M. M.; Price, J. C. (Standard Telecommunication Labs., Ltd., Harlow, Essex, Eng.). Electron. Lett., 1: 182-3(Sept. 1965).**

A method is described for measuring small resistance changes in microminiature circuits while these are subjected to neutron irradiation from an atomic reactor. Sensitivities of a few parts per million have been achieved. (auth)

695 STEADY-STATE RADIATION EFFECTS ON ELECTRONIC COMPONENTS AND CIRCUITS. Magee, R. M. (Bendix Systems Div., Ann Arbor, Mich.). pp 603-18 of Proceedings of the National Electronics Conference. Vol. XIX. Chicago, National Electronics Conference, Inc., 1963.

Recent work on nuclear radiation effects on electronic components from steady-state radiation environments is reviewed. Much of this work relates to semiconductor devices, which are the most radiation-sensitive components usually encountered in electronic systems. Emphasis is placed on: variation of radiation effects with particle energy for neutrons, protons, and electrons; relative effects of different kinds of radiation, including neutrons, protons, electrons, and gamma rays; radiation-induced surface effects in transistors; and reliability predictions based on statistical analyses of effects. The use of the Weibull and exponential distributions in the analysis of radiation effects information is described. The use of this kind of component information in circuit design applications is discussed. Various techniques, such as derating, redundancy, and feedback, may be used to increase the radiation-tolerance of circuits. Some specific development efforts leading to more radiation-tolerant components for future use are field-effect transistors, TIMMS, and Circuitrons. (auth)

ISOTOPE TECHNOLOGY

General

696 (ORNL–3829) REVIEW OF ISOTOPES TARGET PROGRAM, OCTOBER 1963–DECEMBER 1964. Kobisk, E. H. (Oak Ridge National Lab., Tenn.). Sept. 1965. Contract W-7405-eng-26. 40p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Activities of the Isotopes Target Center include the preparation of high purity isotopic metals and compounds, participation in special projects such as Operation HENRE (High Energy Neutron Reactions Experiment) and the preparation of ^{239}Pu-coated fission chambers, and the development of radioisotope target preparation techniques. Impurity levels of isotopic materials were reduced and target quality enhanced by improvement of ultrahigh vacuum systems, the use of electron-bombardment evaporation and simultaneous reduction-distillation of metals, and the purchase of a new foil-rolling mill. Ultrahigh vacuum systems were improved by the use of combined titanium-sublimation and ion pumping. Reactive atmospheric gases could be preferentially removed by this system, and pumping speeds were increased as compared with oil diffusion pumping. Stable isotope targets of GeO_2 and Ga_2O_3 were prepared with film thicknesses of 500 $\mu g/cm^2$ and 50–200 $\mu g/cm^2$, respectively. Preparation techniques for single crystals of ultrahigh purity Si were proposed for the fabrication of neutron spectrometer detectors. The greatest number of radioisotope targets were prepared for Operation HENRE from metal films of Ti or Er sorbed with tritium. Other radioisotope targets were prepared from fissionable materials such as Pu, Np, U, Al–U alloys, and Th. During 1964, more than 1200 targets were fabricated not including ~500 targets prepared for special contracts such as Operation HENRE. Of these targets, 931 were stable isotope targets, 119 were radioisotope targets, and 168 were tritium targets. (J.R.D.)

697 ^{60}Co IRRADIATION UNIT FOR AGRICULTURAL RESEARCH. Marais, P. G.; Potgieter, Lerine; Hawkins, C. S.; Hanekom, J. (Fruit and Good Technology Research Inst., Stellenbosch, S. Africa). S. African J. Agr. Sci., 7: 837-62(1964).

A ^{60}Co irradiation unit is described and illustrated in detail that was designed for the irradiation of a wide range of materials. The ^{60}Co source consists of two 2 x 17 mm discs with a total activity of 488C. The manipulation of the source is entirely mechanical and is controlled from the outside. A labyrinth-type construction attenuates the dose near the chamber. Various sample holders were constructed for the irradiation of fruit, vegetables, soil, microorganisms, plant materials and insects. With the source raised above floor level, dose-rate measurements were carried out in vertical directions at different distances from the source. An important feature of the source arrangement is that samples can be placed close to the source by means of a turntable, so that irradiation of small samples at a dose rate of 500,000 rad/hr, is possible. (TCO)

698 RADIOACTIVE PRODUCTS. RADIOISOTOPES, LABELLED COMPOUNDS, RADIATION SOURCES. CATALOGUE OF RADIOACTIVE PRODUCTS. Amersham, Eng., The Radiochemical Centre, 1965. 203p.

A list of radioactive products available from The Radiochemical Center, Amersham, Buckingham, England is reported. The radioactive products include: radioisotopes and labeled compounds; medical products; services; radiation sources – industrial and laboratory; and radioactive materials for instrument calibration. General information and ordering procedure is also included. (P.C.H.)

699 PROBLEM OF THE USE OF NEUTRON-IRRADIATED PHOSPHORUS FERTILIZERS IN STUDIES OF THEIR EFFECTIVENESS. Smierzchalska, K. (Polish Academy of Science, Warsaw). 12p. (CONF-650614-4). ORINS.

From Symposium on the Use of Isotopes and Radiation in Soil-Plant Nutrition, Ankara.

The greenhouse experiments and laboratory investigations were carried out in order to determine the usefulness of rock-phosphate labeling in neutron flux in studies of its fertilizer value. The laboratory trials concerned different ^{32}P phosphates contained in irradiated rock phosphate (Annofos), and the specific activity of phosphorus soluble during extraction of that fertilizer in weak and strong acids. On the basis of the results obtained and the data from literature it was considered to what extent the non-orthophosphate compounds of ^{32}P may influence the values of phosphorus uptake from fertilizer by plants (determined radiometrically). It was stated that the real values (for phosphorus recovery) could not differ more than about 20%. In greenhouse pot experiments conducted with various plant species using rock phosphate Annofos irradiated and superphosphate-labeled in the laboratory, the phosphorus uptake from fertilizers determined with two methods, radiometric and of differences, was compared. That comparison shows that the results varied significantly; almost all values for phosphorus uptake from fertilizers obtained with the radiometric method were much lower than ones determined with the method of differences. The conclusions were drawn that the use of rock phosphate gave more real values of phosphorus recovery from the fertilizers and from the soil. Using rock phosphate irradiated in the reactor it may be possible to determine (radiometrically) the calcium recovery by plants from that fertilizer. (auth)

Industrial Applications

Refer also to abstract 11.

700 (AD–621921) RESISTANCE OF MICROORGANISMS TO IONIZING RADIATION APPLIED TO FOOD. Anderson, A. W. (Oregon State Univ., Corvallis). Sept. 1965. Contract DA19-129-QM-2035. 13p. (FD–24). CFSTI $1.00 cy, $0.50 mn.

Spores of Clostridium botulinum (33A) were inoculated into canned ground round beef containing various additives and subsequently irradiated. Sodium nitrate (1000 ppm) plus sodium chloride (2.5%) completely inhibited spoilage for 120 days at 35°C when the samples were exposed to 2.0 Mrad γ radiation, and no viable spores or toxin were recovered upon sub-culture. One hundred and twenty five cans were used per run. The use of either additive, with or without radiation, did not prevent spoilage unless higher levels of radiation such as 2.5 and 3.0 Mrad were used, with the concomitant production of undesirable odors. Sodium nitrite (200 ppm) plus sodium chloride (2.5%) inhibited spoilage for 120 days but there was evidence of spore viability and toxin production in some of the unspoiled cans when the radiation level was 2.0 Mrad. Higher levels of radiation gave results similar to those obtained for sodium nitrate and sodium chloride. (auth)

701 (COO-1283-27) IRRADIATION PRESERVATION OF FRESH-WATER FISH AND INLAND FRUITS AND VEGETABLES. Emerson, J. A.; Kazanas, N.; Gnaedinger, R. H.; Krzeczkowski, R. A.; Seagran, H. L. (Bureau of Commercial Fisheries, Ann Arbor, Mich.); Markakis, P.; Nicholas, R. C.; Schweigert, B. S. (Michigan State Univ., East Lansing); Kempe, L. L. (Michigan Univ., Ann Arbor). Aug. 1965. Contract AT(11-1)-1283. 76p.

Progress is reported in studies of the radiation processing of foods. Significant extension of storage life of radiation processed (0.3 megarad) yellow perch fillets was obtained when the product was stored at 33°F. Maximum

storage time was reduced about 50% when the irradiated fish were stored at 42°F. Gamma irradiation (200 krad) of strawberries delayed by 2 to 3 days the rapid decay caused by transportation without refrigeration and subsequent storage at 44°F. The dehydration of prunes was facilitated by γ irradiation at 200 to 400 krad. The sprouting of Arenac and Ontario potatoes was inhibited by 7.5 krad γ radiation. (C.H.)

702 (NYO–3337-16) ISOTOPES IN INDUSTRY. TRENDS IN THE INDUSTRIAL USE OF RADIOISOTOPES AND IONIZING RADIATION. Final Report. Stone, E. W.; George, J. H. B.; Beutner, H. P. (Little (Arthur D.) Inc., Cambridge, Mass.). Sept. 24, 1965. Contract AT(30-1)-3337. 140p. Dep. mn; CFSTI $1.00 cy, $1.50 mn.

Results are presented of a survey of the industrial uses of radioisotopes and radiation. An attempt is made to identify the diversity of uses of radioisotopes in production and research, and to assess the significance of isotope applications in the context of the technology of each industry considered. The areas where significant changes in isotope applications have occurred since 1958 are also identified. The major uses covered include gaging, radiography, tracing, and radiation processing; the industries surveyed include metals, electrical, transportation, chemical process, consumer products, crude petroleum and natural gas, mining, utilities, and research, engineering, and testing. (D.L.C.)

703 STERILIZATION OF SURGICAL SUTURES: COMPARISON OF HEAT AND IRRADIATION. Addison, B. A.; Jennings, E. R. Am. Surgeon, 31: 242-4(Apr. 1965).

A recent report indicated that there were differences in the absorption and tissue reaction between heat-sterilized and electron-beam sterilized gut. However, the present experimental and clinical evaluation of fascial closure with 00 chromic surgical gut revealed no significant differences in the response to these sutures. In the experimental study, in 20 dogs the anterior rectus sheath fascia was closed in an equal manner for an equal distance with heat-sterilized and electron-beam sterilized gut, and gross examinations and microscopic sections were done at 2, 4, and 8 weeks. A clinical study was conducted on 46 consecutive general surgical cases. The anterior rectus sheath was closed with 00 chromic sutures, half of which was heat sterilized and half irradiation sterilized. Follow-up examinations were recorded with the differences in tissue reaction and induration determined by palpation at 2, 4, and 8 weeks. In the dogs and patients there was no appreciable difference in tissue reaction or rate of absorption of the two materials. In 17 instances in patients there was more reaction associated with the heat-sterilized gut and in five instances more with the electron-beam sterilized gut. The latter reactions were all seen in the first few weeks; there was no detectable difference in any of the tissues at 8 weeks. It therefore is assumed that the earlier reported differences were due to factors other than methods of sterilization. (BBB)

704 USE OF RADIOACTIVE LIGHT SOURCES IN MINE SAFETY. Adam, Laszlo. Atomtech. Tajekoztato, 8: 273-82(1965). (In Hungarian).

For many years inorganic phosphors, such as Cu or Ag-activated ZnS excited by the α radiation of natural radioisotopes were used exclusively in light sources but because of their high price and short useable life, they were abandoned in favor of the artificial β emitters. Radioluminescence devices are used in underground mine-safety appliances because they are independent of external power sources. To be approved for underground use, the signs, directional indicators, signaling devices, etc., must have a surface luminosity of at least 1 candle/m^2; auxiliary radioactive lamps must be 10 times more luminous. The devices must be able to resist flooding and fire; the β radiation at the surface must be below detectable levels and the bremsstrahlung dose must not exceed 2 mR/hr at 0.5 m. They also should have a useful life of about 10 years and the weight of portable equipment should not exceed 3 kg. $^{90}Sr/Y$ was used as the radiation source by incorporating it into enamel or silicone lacquer. The Cu-activated ZnS phosphor was made into a homogeneous mixture with polystyrene. In order to reduce the bremsstrahlung, elements with a mass number higher than that of Si were eliminated. (40 references) (TTT)

705 REPORT ON THE EXPERIENCES GAINED DURING A TRIP TO POLAND. Abelovszky, Laszlo. Atomtech. Tajekoztato, 8: 283-92(1965). (In Hungarian).

The economic problems involved in the industrial application of isotopes in Poland and in Hungary were compared on the basis of information collected during a study trip to Poland in January 1965. The foundations are considered well prepared in Poland for introducing the isotopes into production plants and industrial laboratories. The output of the EWA reactor in Swierk supplies about 10% of the requirements. With the start of a second reactor and an isotope production plant, the production will increase by a factor of 2.5 and will be able to satisfy about 17% of the increased demand. Problems were encountered when attempting to introduce defectoscopic, tracer, and other isotopic techniques in the industrial plants. Potential fields of interest for isotopes include the automatization of mine railroad switches, density measurements, thickness gages, fire alarms, and flaw detectors in the pipe welding and shipbuilding industries. (TTT)

706 INDUSTRIAL UTILIZATION OF RADIOISOTOPES. Schmidt-Kuester, W.-J.; Mohrhauer, H. (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg, Ger.). Atomwirtschaft, 10: 536-8(Oct. 1965). (In German).

The uses of radioisotopes in the wood and paper, tobacco, metallurgical, petroleum, and coal industries are summarized. (J.S.R.)

707 TOXIN PRODUCTION BY CLOSTRIDIUM BOTULINUM, TYPE E, IN VACUUM-PACKED, IRRADIATED FRESH FISH IN RELATION TO CHANGES OF THE ASSOCIATED MICROFLORA. Abrahamsson, Kerstin (Swedish Inst. for Food Preservation Research, Goeteborg); DeSilva, N. N.; Molin, N. Can. J. Microbiol., 11: 523-9 (June 1965).

An investigation was made of botulin production in irradiated fish packed in laminated polythene bags. Irradiation and packing were also studied for their effect, if any, on the normal spoilage flora. Thawed herring fillets were inoculated with the spores and then packed in polythene bags. Some samples were vacuum-packed; some were not; and others were packed in open bags. Two sets of fillets, one of which was inoculated with the spore suspension at a level of 2×10^6 per 60 g of muscle, were γ irradiated with a dose of 0.1, 0.3, or 0.6 Mrad from a ^{60}Co source. They were then incubated at 20°C together with control packs which were not irradiated. All the packs were examined for toxin after 40 hours. Judging from examination of the fillets after 40-hr incubation at 20°C, irradiation with 0.3 and 0.6 Mrad prevented toxin production as well as the more obvious type of spoilage changes. On longer storage (64 hr), however, the samples that received 0.3 Mrad became toxic. The unirradiated packs and the packs that had received the smallest dose (0.1 Mrad), exhibited a significantly higher concentration of toxin in the vacuum-packed than in the nonvacuum-packed samples. Changes in the associated spoilage flora lent further support to the view that oxygen scavenging by aerobic bacteria favors the growth of clostridia. The flora surviving after irradiation with 0.6 Mrad consisted solely of micrococci that were sensitive to antibiotics such as penicillin and oxytetracycline. The vacuum-packing considerably increased the strength of toxin present after 48 hours. On further prolonged storage at 20°, however, the concentration of the toxin became roughly equal in all three cases. (BBB)

708 PROGRESS OF FOOD IRRADIATION WORK AND PROGRAMMES IN O.E.C.D. MEMBER COUNTRIES. Food Irradiat., 5: No. 4, A2-18(Apr.-June 1965).

The status of research and developmental studies on food irradiation in 1965 is summarized for Austria, Belgium, Canada, Denmark, France, German Federal Republic, Italy, The Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Research programs include studies on toxicity and nutritional value of irradiated foods. Developmental studies include various means of quality improvement, methods of extending storage life, and public acceptance of irradiated foods. Foods cleared by the U. S. Food and Drug Administration include wheat and wheat products, bacon, white potatoes, and packaging materials. Foods under intensive investigation include chicken, pork, luncheon meats, pre-cooked meat dishes, fish and other marine foods, onions, carrots, tomatoes, dehydrated vegetables, apples, strawberries, sweet cherries, raspberries, peaches, grapes, bananas, and tropical fruits such as papayas and mangoes. Related studies include studies on the radiosensitivity of certain bacteria involved in food poisoning, such as clostridium botulinum and salmonellae, and the control of insect pests that infest foods by irradiation. (C.H.)

709 STUDY GROUP ON FOOD IRRADIATION HEALTH AUTHORITIES AND THE CONTROL AND IDENTIFICATION OF IRRADIATED FOODS. Lafontaine, A. (Institut d'Hygiene et d'Epidemiologie, Brussels); Kuprianoff, I. Food Irradiat., 5: No. 4, A19-21(Apr.-June 1965).

Public health aspects of the radiation processing of foods are considered. Emphasis is placed on problems that may arise due to the importation of radiation processed foods. Possible inspection methods are discussed. (C.H.)

710 USE OF RADIOISOTOPES, ESPECIALLY IN THE FORM OF OPEN PREPARATIONS, IN WOOD TECHNOLOGICAL PROBLEMS. [PART] I. Scheele, W. Holztechnologie, 4: 61-8(Mar. 1963). (In German).

A review was made of publications, which appeared until the end of 1962, on the actual and possible use of radioisotopes and radiation in solving numerous problems in wood technology. Discussions are included on the detection of radiation, official regulations, practical methods of radiation protection, the degree of danger involved in handling the more commonly used radioisotopes, the construction and equipment of radiation laboratories, the use of radiation to produce certain effects in living and nonliving matter, the use of radiations emitted by radioisotopes for measurement and detection purposes, and tracer methods for measuring the movement and distribution of substances. (OID)

711 USE OF RADIOISOTOPES, ESPECIALLY IN THE FORM OF OPEN PREPARATIONS, IN WOOD TECHNOLOGICAL PROBLEMS. [PART] II. Scheele, W. Holztechnologie, 4: 99-104(Aug. 1963). (In German).

Fundamental investigations on wood chemistry and wood structure carried out with the help of radioisotopes are reviewed. Investigations of ^{14}C-labeled lignins, the permeability of wood for various substances, wood drying, wood preservation, and wood pulp production are discussed. The effects of nuclear radiation on wood and wood-destroying micro-organisms, measurement of the crude density of raw wood by means of γ radiation from a ^{60}Co source; and the application of radioisotopes in the manufacture of wood products such as the production of compressed wood fiber plates, the distribution and recovery of resins from wood, and the use of radioisotopic tracers and radiation in the paper industry are considered. (OID)

712 INCREASED GRANULOMA FORMATION FROM ABSORBABLE SUTURES. Gaskin, E. Reed; Childers, Melvin D. Jr. J. Am. Med. Assoc., 185: 212-14 (July 20, 1963).

Unfavorable tissue reactions which have developed in response to radiosterilized (by high-energy electrons) suture materials, and not seen with heat-sterilized sutures, are reported. During the past 18 months, original observations and discussions with opthalmologists and general surgeons reveal that suture reactions of delayed and prolonged granuloma formations after the use of catgut suture materials have increased alarmingly. The granuloma formations appear about 3 weeks after surgery, which would rule out allergic immediate responses (24 to 48 hrs) and delayed responses (1 week ± 2 days). It was also noted that the suture material remained in the tissues, without being absorbed, for a prolonged period, and that material from the same strand varied widely in rate of absorption. (TCO)

713 INVESTIGATIONS OF THE INFLUENCE OF RADIOACTIVE RAYS ON PHARMACEUTICALS. [PART] III. Buechi, J.; Iconomou, N. (Eidgenoessische Technische Hochschule, Zurich). Pharm. Acta Helv., 40: 421-31(1965). (In German).

The irradiation of d-limonene was investigated because of the use of terpenes in pharmaceutical preparations and because of their relation to the steroids and some vitamins. Ten ml of limonene was irradiated with a ^{60}Co source, using a dose of 100 Mrad. Products were analyzed by gas chromatography on four columns; a table of retention times is given for 16 terpenes and terpinols. The gas chromatograms before and after irradiation are shown; there is no difference. Polymer is formed to the extent of 1% with 2.5 Mrad, 11% (mp 58°C) with 60 Mrad, and 19% (mp 63°C) with 100 Mrad. A study of solutions of phenol and camphor in ethanol was also made. Ten % solutions were irradiated using doses up to 100 Mrad. The products were analyzed gas chromatographically, and in addition a titrimetric study of possible camphoric acid formation was used. In both cases the chromatograms were the same before and after the irradiation, even quantitatively by comparison with known amounts of o-dichlorobenzene. Only the solvent was susceptible to radiation, a phenomenon already described. (BBB)

714 APPLICATION OF GAMMA RAY LEVEL GAUGES FOR CONTROLLING GLASS FURNACES. Loverdo, A. Verres Refractaires, 18: 369-73(Sept.-Oct. 1964).

The advantages and means of applying level control by gamma rays to melting tank furnaces are discussed. A device is described and its operation illustrated by stressing its practical performances. Proportional regulation devices of the pulse type, in conjunction with gamma ray level gages for glass furnaces, are also described. (French Technical Press, No. 1, 1965)

715 CHECKING THE WEAR OF REFRACTORIES BY RADIOACTIVE INSERTS. Broquet, C. Verres Refractaires, 18: 461-5(Nov.-Dec. 1964).

The insertion of radioactive sources for measuring the wear of refractories was recently performed on blast furnaces. These facilities take advantage of the considerable progress achieved in conditioning the sources. The sources employed consisted of ^{60}Co "pyrocerame" and were detected by means of a portable scintillator. The potential applications cover all high-temperature processing or manufacturing devices. The concept of labeling, the operational mode, and the conditions of safety are described. Work performed on two French blast furnaces is reviewed. (French Technical Press, No. 1, 1965)

716 GAMMA-RAY ATTENUATION COEFFICIENTS OF GRAINS AND FORAGES [Thesis]. Ruwe, Dean Melvin. Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 151p.

Narrow-beam attenuation measurements were made on corn, milo, oats, soybeans, wheat, alfalfa hay, and oat straw. The linear and mass attenuation coefficients were determined using the 1.33- and 1.17-Mev gamma rays from ^{60}Co and the 0.662-Mev gamma rays from ^{137}Cs. The moisture contents of the grains were increased from approximately 10 to 25 percent in increments of 1 percent. Two different grain densities were examined at each of the moisture contents. Theoretical attenuation coefficients were calculated based on feeding analyses and Klein-Nishina cross sections for Compton scattering. It was found that the mois-

ture content had no effect on the attenuation coefficients except as it influenced the grain density. The agreement between the measured and theoretical values was generally within ±5 percent. General relations between the attenuation coefficients, the material density, and the gamma energies were established. (TCO)

717 SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP–7 SERIES) (Engineering Materials). (Martin Co., Baltimore, Md. Nuclear Div.). (CAPE–1232). 132 drawings.

The six systems of the SNAP-7 series described are used in generating electrical power for use in out-of-the-way locations such as navigational aids and weather stations. Each has a ^{90}Sr-fueled generator that will operate at the designed output for 10 years, and without maintenance or attendance for two-year periods. These systems are: Navigational Buoy, SNAP-7A; U. S. Coast Guard Automatic Light Station, SNAP-7B; U. S. Navy Weather Station, SNAP-7C; U. S. Navy Weather Station Buoy, SNAP-7D; Thermoelectric Generator, SNAP-7E; and Navigational Aid, SNAP-7F. (For details, see TID-4100) (M.C.G.)

718 EFFECT OF HYPOXANTHINE ON THE FLAVOR OF FRESH AND STORED LOW-DOSE IRRADIATED PETRALE SOLE FILLETS. Spinelli, John (Bureau of Commercial Fisheries Technological Lab., Seattle). 13p. (CONF-650552–4). Gmelin, AED-CONF-65-111-2.

From Institute of Food Technologists, 25th Annual Meeting, Kansas City, Mo.

Dilute aqueous solutions of hypoxanthine were found to be predominantly bitter. Triangle tests showed, however, that the addition of hypoxanthine to fresh and stored low-dose irradiated petrale sole containing less than 10^6 bacteria per gram did not alter flavor. Flavor alteration due to added hypoxanthine was detectable in the irradiated fish only when the total bacterial counts exceeded 10^6. (auth)

719 FOOD PRESERVATION BY IRRADIATION—PRESENT STATUS. Schultz, H. W.; Lee, Jong S. (Oregon State Univ., Corvallis). 22p. (CONF-650552–3). Gmelin, AED-65-111-3.

From Institute of Food Technologists, 25th Annual Meeting, Kansas City, Mo.

The status of food preservation by irradiation in 1965 is reviewed. The sterilization of bacon, disinfestation of grain, sprout inhibition of potatoes, and the pasteurization of fish appear to be promising for commercial development. Irradiated milk is not promising from the standpoint of acceptability and feasibility, but the radiation processing of aged cheese is promising. The pasteurization of poultry is questionable as far as product acceptability is concerned. Sterilized fresh pork and beef are feasible but the product has low acceptance, as does pasteurized frankfurters, cured luncheon meats, and canned ham. Strawberries are the most promising fruit for radiation pasteurization to reduce loss due to rapid spoilage. Cranberries are in the same category. Tropical fruits may prove acceptable. Radiation processing of fish and shellfish for extension of the storage life has been proved acceptable for some fish products. The radiation processing of ripe tomatoes to reduce mold is considered feasible. (C.H.)

720 HEAT-SHIELD ABLATION AND SUBLIMATION DETERMINATIONS THROUGH RADIOISOTOPE TECHNIQUES. Davis, William G.; Brandon, George W. (Manned Spacecraft Center, Houston, Tex.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint No. 65-362, 8p., $1.00. (CONF-650711–30). ORINS.

From AIAA 2nd Annual Meeting and Technical Demonstration, San Francisco.

Continuous measurement techniques for the determination of Apollo heat-shield sublimation (char) and surface recession (ablation) are presented. These techniques for measuring char and ablation are described and related to the process by which the heat shield protects the reentry module. Radioactive "line" sources embedded in the heat-shield material sublime and ablate at the same rate as the heat shield. Decreases in source activity are monitored by miniaturized nuclear counters. Since these measurement techniques utilize radioisotopes, special reentry simulation testing procedures are reported. Test results, sources of error, and total measurement accuracy are discussed. (auth)

721 ZERO-GRAVITY RADIOTRACER PROPELLANT GAUGE. Wakeman, J. F.; Burns, B. (TRW Systems Group, Redondo Beach, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint No. 65-364, 8p., $1.00. (CONF-650711-31). ORINS.

From AIAA 2nd Annual Meeting and Technical Demonstration, San Francisco.

A radiotracer propellant gage concept was developed. The gage is insensitive to propellant tank shape, materials, and wall thickness. It can be easily installed, removed, or transferred from one tank to another. When the tank is full of propellant a small quantity of radioactive gas such as ^{85}Kr is injected into the ullage space and the tank is pressurized. As the propellant is consumed from the tank the ullage space volume increases and, therefore, the volume concentration of the radioactive gas is decreased. This dilution effect is continuously measured. The measured count rate, which is proportional to the ^{85}Kr concentration, is related to the propellant remaining by means of a simple algebraic equation. The gage proved equally accurate for both constant pressure and blowdown systems, and can also be adapted to vented systems. No discernible external radiation field exists. Testing of this gage was conducted with a full-scale boilerplate model of the Apollo reaction control system tankage that can be rotated about the horizontal axis. (M.C.G.)

Power Application

See *also* ENGINEERING — Space Propulsion

722 (GA–4554(Rev.)) FINAL SAFETY AND HAZARDS REPORT FOR THE SNAP–15A GENERATOR. Campana, R. J.; Bold, F.; Dexter, R. W.; Homeyer, W. G.; Sargent, W. E.; Wallace, W. P. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). Oct. 30, 1964. Contract AT(04-3)-167. 109p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

The basic criteria for the use of ^{238}Pu were established and the maximum credible accident to the SNAP-15A generator was defined. The most serious of possible accidents were found to be fire, impact, and loss. A safety test program was devised based on the generator and capsule design and hazard analysis. Ten types of tests were conducted to prove the adequacy of the design and the safety aspects of the capsule and generator in the event of the maximum credible accident. The tests were: fire, thermal shock, pressure burst, impact, vibration, hammer drop, salt water corrosion, fresh water corrosion, air corrosion, and dose-rate measurement. The test results demonstrate that the capsules and generators are safe in all respects except for impact under very special conditions with an extremely low probability of occurrence. Procedures used in handling fuel capsules and fueled generators are outlined. A users manual for handling the SNAP-15A generator is included. (M.O.W.)

723 (NP–15531) RADIOACTIVE ISOTOPE FUELED THERMO-ELECTRIC GENERATORS FOR SPACE MISSIONS [Thesis]. de Haas, Ernst (Technische Hogeschool, Eindhoven (Netherlands)). 1964. 166p. Dep. mn.

A critical comparison of the performance of the radioisotope thermoelectric (RTE) generator with that of the solar cell generator for space power applications is made. The comparison is based on two design studies: a brief one on the solar cell power supply, using performance data from existing systems and a more detailed study on the RTE. The construction and manufacturing of the RTE is

described. Because of the large spread in performance of RTE and solar cell power supplies the merits of the two can be compared in detail only for each specific mission. This is done for five standardized missions on the basis of total cost, including freight charges from earth to the desired position in space. (M.O.W.)

724 DEVELOPMENT OF THE GAMMA RADIOISOTOPE THRUSTOR. Buford, William H. Jr.; Greenhow, Charles R. (Marquardt Corp., Van Nuys, Calif.). 18p. (CONF-650602-60). Gmelin, AED-CONF-64-219-133.

From American Nuclear Society, 11th Annual Meeting, Gatlinburg, Tenn.

The first demonstration of the use of a gamma radioisotope heat source for low thrust space rocket propulsion was completed. This demonstration provided the experimental data required to guide the development of a full scale isotope space propulsion system. The use of radioisotopes for the heat source in low thrust space propulsion systems may present substantial payload advantages over other propulsion concepts. The specific impulse attainable with the isotope heating may exceed any presently envisioned chemical rocket systems. The isotope heating element is the maximum temperature region of the thrustor which limits the attainable specific impulse. Topics discussed are the gamma isotope thrustor concept, experimental gamma thrustor design, and the experimental series. The exit gas temperature and specific impulse of the experimental system could have been substantially improved if high specific activity source material had been available and improved thermal energy management achieved. Although the gas temperature level reached in the experiment was disappointing, all pertinent data required to continue the gamma thrustor technology are provided. (J.F.P.)

725 THE EFFECTS OF PROBABILITY OF LAUNCH SUCCESS ON THE LONG-TERM USAGE OF RADIO ISOTOPIC SNAP UNITS. Reed, Gareth L.; Klein, Laurence T. (Nuclear Utility Services, Inc., Washington, D. C.). 22p. (CONF-650540-5). Gmelin, AED-CONF-65-116-8.

From American Industrial Hygiene Association Meeting, Houston, Tex.

A review of the development of radio isotopic SNAP units is given. The topics discussed include the technical approach, the atmospheric model, launch success probability, and acceptability criteria. It is assumed that a space program requiring ten launches a year for a period of ten years is proposed. Apportionment of the number of failures as a function of launch success is important to the results of the analysis. The failure distribution assumed is tabulated. It appears that if the safety criteria of this study were applied to forthcoming isotopic power units their utilization would be severely limited with respect to launch frequency and/or unit size. Ways to alleviate the situation are suggested. (J.F.P.)

726 UNDERWATER ACOUSTIC BEACON—ISOTOPE POWERED (Engineering Materials). (Martin Co., Baltimore, Md. Nuclear Div.). (CAPE-1240).

56 drawings.

The ^{90}Sr-powered underwater acoustic beacon described consists of a boiler, power converter, and hydroacoustic oscillator. The heat from the decay of ^{90}Sr is converted to acoustic energy by fluid-mechanical means. The teflon-sealed boiler is fabricated of 316 stainless steel that has high resistance to sea water and steam. The power converter provides driving energy to the hydroacoustic oscillator by converting steam from the boiler to pulses of hydraulic energy at regular intervals. The hydroacoustic oscillator has a sound frequency of 2 to 5 kc, and a signal energy of 100 w. The system has a signal frequency of ~5000 cps; an adjustable duration signal from ~15 to 30 msec; a range of 20 miles; a weight of 1300 lb; and is designed to operate at a depth of 200 ft. It operates in sea water for five years at temperatures of 32 to 80°F. (For Details, See TID-4100) (M.C.G.)

Separation and Production

See also CHEMISTRY — Separation Processes and Procedures

727 THERMAL DIFFUSION CELLS (Engineering Materials). (Oak Ridge National Lab., Tenn.). CAPE-1210).

24 drawings.

The cells described are used in the isotopic separation of krypton to produce ^{85}Kr by the thermal diffusion method. There are 2 cells, each working as a separate plant. Three columns containing 36 tubes are located in each cell. Two of the columns supply feed for the third column, which produces ^{85}Kr of 50% concentration. Pulse type thermal diffusion gas pumps located in a cubicle with 2-in.-thick, lead brick vertical walls are used. (For Details, see TID-4100). (M.C.G.)

728 METHOD OF DETERMINATION OF THE CHARACTERISTICS OF POROUS BARRIERS AND INSTRUMENT FOR THE PRACTICAL APPLICATION OF SAID METHOD. Eyraud, Charles; Eyraud, Yvan; Gayral, Marcel; Gilles, Pierre; Massignon, Daniel (to Commissariat a l'Energie Atomique). British Patent 1,005,134. Sept. 22, 1965. Priority date July 20, 1962, France.

A method and apparatus are described for the comparison of the pore size of porous barriers of filters with a standard barrier or filter. The method consists of the following steps: the barrier to be studied is interposed between two chambers; an abrupt pre-determined variation in volume of one of the chambers is applied; the abrupt variation is followed by a slow variation of volume with respect to time according to a pre-determined law; and the pressure difference between the two chambers is measured. The pre-determined law is so selected that the pressure difference remains substantially constant in the case of the standard barrier that has a pre-determined mean pore radius. (B.L.M.)

729 METHOD FOR THE REDUCTION OF DEUTERIUM LOSSES IN ISOTOPIC EXCHANGE WITH A LIQUID CYCLE. Nitschke, Eberhard (to Friedrich Uhde G.m.b.H.). German Patent 1,198,799. Aug. 19, 1965. Filed Feb. 16, 1963.

Deuterium is obtained by the isotopic exchange between hydrogen gas and liquid ammonia circulated through an exchange column. The hydrogen gas from the concentration portion of the column which is loaded with vaporous ammonia is extracted by means of liquid ammonia in a counter current column. The washing liquid is recirculated into the circuit of the liquid exchange medium. (Gmelin Inst.)

730 METHOD FOR THE PRODUCTION OF RADIOACTIVE SUBSTANCES. Corneil, Hampton G.; Suttle, Andrew D. (to Esso Research and Engineering Co.). German Patent 1,200,448. Sept. 9, 1965. Priority date Mar. 21, 1958, United States.

Substances are activated by the detonation of a nuclear energy generating device in a cavity in an isolated compact subterranean formation. The radioactive substances obtained are withdrawn from the cavity. (Gmelin Inst.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 167, 1111, and 1236.

731 (AERE-M-1627) PROPOSED SPECIFICATION OF A COMPUTING SYSTEM USING REMOTE CONSOLES: HUW. Pyle, I. C. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 19p. Dep.; BIS $0.60; HMSO 3s. 0d.

HUW (Harwell Users' Workshop) is essentially a file maintenance and message switching system in which a number of users at remote terminals can have access to a number of programs being executed concurrently by a central computer. Standard programs would exist for use from any terminal, some of which would allow the user to originate new programs to be executed either immediately or later. Bulk storage would be available for keeping files of information (data or programs), which may be accessed by programs in the computer. (auth)

732 (COO-614-37) ICR QUARTERLY REPORT NUMBER 6, AUGUST 1, 1965. Miller, Richard H. (Chicago Univ., Ill. Inst. for Computer Research). Contract AT(11-1)-614. 102p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

Eight papers are included. Two papers appeared previously in NSA as 19: 39080 and 46792. The five papers that were not abstracted discussed Maniac III engineering activity, FORTRAN IV mathematical subroutine library, a disk oriented operating system, fixed point theorems and their extensions, and convex quadratic programming. An abstract was prepared for one paper. (M.O.W.)

For an abstract of the individual paper see: 650.

733 (CRT-1167) FREAK: A G-20 COMPUTER PROGRAM FOR MAKING FREQUENCY DISTRIBUTION TABLES. Attree, P. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1963. 55p. (AECL-1837). Dep.; AECL $1.50.

FREAK is a program written in APEX for the G-20 computer. It is designed to make up frequency distribution tables, according to prescribed distributions and field definitions, from a file of records which may be either on magnetic tape or on cards. (auth)

734 (JINR-P-1988) ON A METHOD OF FINDING CONVENTIONAL EXTREMA. Zhydkov, E. P.; Luk'yantsev, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 6p. Dep. mn.

A problem of finding a conventional extremum for the function $f(\overline{x})$ at the constraints $\phi_i(\overline{x}) = 0$ reduces to finding the absolute extremum for the function $\phi_T(\overline{x}) = f(\overline{x}) + T \Sigma_i \phi_i(\overline{x})$, where T is the positive parameter. (auth)

735 (NRL-6288) TABLES OF SPHERICAL HANKEL FUNCTIONS OF IMAGINARY ARGUMENT. Knudson, A. R. (Naval Research Lab., Washington, D. C.). Mar. 31, 1965. 96p.

Tables of the spherical Hankel functions for imaginary values of the argument were calculated. The computation of these tables was performed by an LGP-30 computer and the computer output photographed to eliminate the possibility of errors being introduced in reproducing the tables. The values presented in these tables correspond to $-(i)^n h_n^{(1)}(ix) = -(-i)^n h_n^{(2)}(-ix)$ where n = 0(1)8 and x = 0(.01) 10.00. (auth)

736 SOME HILBERT SPACES OF ANALYTIC FUNCTIONS. [PART] II. De Branges, Louis (Purdue Univ., Lafayette, Ind.). J. Math. Anal. Appl., 11: 44-72(July 1965).

The study of Hilbert spaces of analytic functions which are involved in the structural analysis of nonself-adjoint transformations in Hilbert space is continued. (D.C.W.)

737 LINEAR AND ANTILINEAR TRANSFORMATIONS. Neuwirth, Jerome H. (NASA, Greenbelt, Md.). J. Math. Anal. Appl., 11: 73-7(July 1965).

It was previously proved by Lomont and Mendelson (Ann. Math., 78: 548-559(1963)) that if two operators (not necessarily linear) on a Hilbert space (not necessarily separable) behave as if one is the adjoint of the other relative to the absolute value of the inner product, then, except for a phase factor, they are linear and adjoint or antilinear and adjoint to each other. An extension and a simplified proof of the theorem are given. (D.C.W.)

738 ON NON-COMPACT GROUPS. I. CLASSIFICATION OF NON-COMPACT REAL SIMPLE LIE GROUPS AND GROUPS CONTAINING THE LORENTZ GROUP. Barut, A. O.; Raczka, R. (International Atomic Energy Agency, Piazza Oberdan, Trieste). Proc. Roy. Soc. (London), Ser. A, 287: 519-31(Sept. 28, 1965).

The classification of all simple real Lie groups is discussed and given explicitly in the form of tables. In particular, four classes of groups are identified which contain the Lorentz group. These are the groups which leave bilinear forms in real, complex and quaternionic spaces invariant, and the unimodular group in n-dimension. (auth)

739 ON NON-COMPACT GROUPS. II. REPRESENTATIONS OF THE 2 + 1 LORENTZ GROUP. Barut, A. O.; Fronsdal, C. (International Centre for Theoretical Physics, Piazza Oberdan, Trieste). Proc. Roy. Soc. (London), Ser. A, 287: 532-48(Sept. 28, 1965).

A simple algebraic method based on multispinors with a complex number of indices is used to obtain the linear (and unitary) representations of non-compact groups. The method is illustrated in the case of the 2 + 1 Lorentz group. All linear representations of this group, their various realizations in Hilbert space as well as the matrix elements of finite transformations were found. The problem of reduction of the direct product is also briefly discussed. (auth)

740 CONTINUOUS GROUPS IN QUANTUM MECHANICS. Pauli, W. pp 85-104 of Ergebnisse der Exakten Naturwissenschaften. 37 Band. Berlin-New York, Springer-Verlag, 1965.

Representation theory is presented for finite continuous groups. Representations of Lie groups, inhomogeneous rotation groups, the four-dimensional rotation group, and the Lorentz group are considered. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 554, 1352, and 1534.

741 (ANL–7057) PREPARATION OF METALS BY MAGNESIUM–ZINC REDUCTION. PART I. REDUCTION OF URANIUM OXIDES. Knighton, J. B.; Steunenberg, R. K. (Argonne National Lab., Ill.). June 1965. Contract W-31-109-eng-38. 18p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The use of liquid magnesium–zinc alloy for the reduction of uranium oxides to the metal was investigated. The uranium oxide was suspended in a flux composed of alkali and alkaline earth halides and reduced by vigorously mixing the flux-oxide slurry with zinc-5 wt. % magnesium alloy at temperatures between 650 and 800°C. The reductions were conducted in an alumina crucible under an air atmosphere. As the uranium metal was produced, it dissolved in the liquid-metal alloy, from which it could later be recovered by vacuum distillation of the zinc and magnesium. The effects of flux composition, temperature, agitation, magnesium oxide loading in the flux, and uranium oxide particle size on the rate and extent of reduction were investigated. Under optimum conditions, over 99% reduction of U_3O_8 was achieved in periods as short as 10 min on the laboratory scale (4 g of uranium). Uranium losses inherent in the process are well below 1%. (auth)

742 (ANL–7058) PREPARATION OF METALS BY MAGNESIUM–ZINC REDUCTION. PART II. REDUCTION OF THORIUM DIOXIDE. Hariharan, A. V.; Knighton, J. B.; Steunenberg, R. K. (Argonne National Lab., Ill.). June 1965. Contract W-31-109-eng-38. 17p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The preparation of thorium metal by reduction of thorium dioxide with liquid magnesium–zinc alloy was investigated on a laboratory scale. The extent of reduction was determined as a function of time, amount and composition of flux, temperature, agitation, particle size of the oxide, and magnesium concentration in the alloy. The rate and extent of reduction were improved by the use of an argon atmosphere, although complete reductions were achieved in an air atmosphere. The reduction rates of thorium dioxide were slower than those obtained with U_3O_8, but the effects of changes in the flux composition were similar. Under optimum conditions, over 99% reduction of thorium dioxide was obtained in less than 4 hr, and product purities up to 99.7% were achieved. Four small-scale demonstration experiments were performed, in which thorium dioxide was reduced by zinc–magnesium alloy, the resulting liquid-metal solution was distilled to produce a thorium metal sponge, and the sponge was consolidated by arc-melting. It was also shown that thorium tetrafluoride is readily reduced by this method. (auth)

743 (BNL–939) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 3, Number 3, June 1965. (Brookhaven National Lab., Upton. N. Y.). Sept. 1965. Contract AT(30-2)-Gen-16. 75p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Thirty-one reviews of progress and topical reports relevant to liquid metals at high temperatures are presented. Data tabulations and diagrams from the various reports and subject and issuing organization indexes are included. (W.L.G.)

744 (BNWL-120) METALLURGY RESEARCH OPERATION QUARTERLY PROGRESS REPORT, APRIL–JUNE 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 15, 1965. Contract AT(45-1)-1830. 131p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

Progress in research in physical metallurgy, reactor metals, chemical metallurgy, and materials engineering is reported. Separate abstracts were prepared for each section. (W.L.G.)

For abstracts of individual sections see: 745, 746, 762, and 889.

745 (BNWL–120, pp 3.1-22) PHYSICAL METALLURGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A series of Mo foils with varying amounts of prestrain were irradiated at 60°C to 7×10^{18} nvt (E > 1 Mev) and subsequently examined by electron microscopy. Because the density of defect clusters was not affected by a high dislocation density, it was concluded that dislocations do not act as sinks for the point defects that comprise the clusters. Subsequent straining of the foils causes new dislocations rather than the old ones to move from boundaries and to form channels parallel to {110}. Dislocation channeling was observed in irradiated and deformed Re. Most channels were parallel to $\{10\bar{1}0\}$ prism planes and some were parallel to basal planes. $\{11\bar{2}1\}$ was the most common twinning plane. Mo crystals containing C as intentional impurity were irradiated in the as-grown state to 1×10^{20} nvt and changes in length were determined. Length increases ranged from 0.05 to 0.06%, and were independent of C content. Comparison of lattice parameter and length changes in as-grown crystals with those of annealed crystals after an irradiation to 7×10^{18} nvt leads to the conclusion that vacancies are more abundant in the annealed crystals and that dislocations in the as-grown crystals are effective sinks for the vacancies formed during irradiation. Strain rate change tests conducted on ⟨149⟩ axially oriented tensile specimens of Mo, which were annealed at 1300°C for 16 hr prior to testing, show that activation volume decreases with increasing strain. The low value of activation volume, 10 b^3, suggests the Peierls mechanism to be rate controlling. The effect of prior tensile and compressive deformation of the stable phase of Pu on subsequent transformations was investigated. The transformation rates of $\beta \rightarrow \gamma$, $\gamma \rightarrow \beta$, and $\alpha \rightarrow \beta$ are all increased, whereas that of $\beta \rightarrow \alpha$ is decreased. It is concluded that the $\beta \rightarrow \alpha$ transformation is martensitic and that the others are martensitic, diffusional, or both. The effect of uniaxial tensile and compressive stresses on the temperature for the start of the $\alpha \rightarrow \beta$ transformation was determined. The data are consistent with the premise that the $\alpha \rightarrow \beta$ transformation is predominantly martensitic. The x-ray diffraction pattern obtained from β-phase Pu formed from α differs from β-phase Pu formed from γ. These differences, which can be eliminated by heat treatment in the β-phase temperature range, are tentatively explained on the basis of differences in structure and internal stresses. Irradiation of Ferrovac E and a higher purity zone-refined iron to an exposure $< 5 \times 10^{18}$ nvt produces no detectable change in microstructure, as revealed by transmission electron microscopy, but does produce a change in activation volume. Metallography and density measurements on 10 specimens irradiated at 575°C and 1000 psi show that pressure reduces swelling in high purity U by factors as high as 5 to 40, depending on grain size. Pressure also reduces swelling in U–Fe–Al–Si–C alloy specimens but by factors of 2 to 5. Pressure is effective in reducing intragranular pores and tears that are generally aligned crystallographically. (W.L.G.)

746 (BNWL–120, pp 6.1-11) MATERIALS ENGINEERING. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Tests that were completed on foil insulation in a flowing He gas loop system indicate that with proper joint design the thermal conductivity is the same in both static and dynamic systems. Testing was started on the prototypical Advanced Test Reactor (ATR) gas seal for the in-reactor pressure tube. A new model gas loop heater was designed and built to incorporate and investigate essential details

of a compact two-stage heater presently being designed for the ATR Gas Loop. Stress-rupture tests of irradiated PRTR Zircaloy-2 pressure tube segments suggest that increasing amounts of fast neutron exposure may decrease time-to-rupture; however, some annealing of the as-irradiated strength occurs during the stress-rupture test. The yield strength versus temperature curve for N-Reactor Zircaloy-2 pressure tubing was measured to −33°C, showing virtually a linear relation from that temperature to 300°C. A series of crack propagation tests on Zr−2.5 wt % Nb pressure tubing at temperatures ranging from −23 through +265°C were performed. These tests show that significant crack propagation does not occur at or above room temperatures. (W.L.G.)

747 (EURAEC–1391) PREPARATION AND COATING OF SPHERICAL PARTICLES OF PuO_2 AND $(U–Pu)O_2$ MIXTURES. Special Report No. 19. Sari, C.; Lafontaine, I. (Societe Belge Pour l'Industrie Nucleaire, Brussels; Centre d'Etude l'Energie Nucleaire, Brussels (Belgium)). [nd]. Contract 27-60-7 RDB. 22p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

A procedure was developed for the preparation of spherical particles with a diameter between 100 and 250 μ with a yield of about 30% after each 2-hour cycle. 50 to 70% of the particles included within these limits are between 100 and 160 μ in diameter. Optimization of frequency, powder, and vibration time was not attempted. The particles are prepared without the addition of a bond, and without the powders undergoing special treatment, apart from fine grinding. The mechanical strength of the spherical grains, prepared with a powder derived from the low temperature calcination of plutonium oxalate is very good, whereas the particles formed from powders that have already been sintered have to be handled taking certain precautions before the final sintering. The method of chemically coating particles of PuO_2 and $(U,Pu)O_2$ mixtures with nickel is easily adapted to glove-box handling. (D.L.C.)

748 (NLCO–965) SUMMARY TECHNICAL REPORT FOR THE PERIOD JULY 1–SEPTEMBER 30, 1965. Burgett, R. (ed.) (National Lead Co. of Ohio, Cincinnati). Oct. 20, 1965. Contract AT(30-1)-1156. 39p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Separate abstracts were prepared for the 6 sections of the report. (W.L.G.)

For abstracts of individual sections see: 230, 749, 750, 784, 785, and 825.

749 (NLCO–965, pp 1.1-5) USE OF CUT-CROWN MAGNESIUM IN THE PRODUCTION OF URANIUM METAL. Mautz, E. W.; Briggs, G. G.; Bonfer, D. C.; Gindlesperger, J. L. (National Lead Co. of Ohio, Cincinnati).

Cut-crown magnesium was used to reduce UF_4 to metal in several pilot- and production-scale tests designed to compare this lower-cost form of magnesium with the chipped-ingot magnesium previously used. The cut-crown magnesium produced generally satisfactory metal. (auth)

750 (NLCO–965, pp 6.1-8) IDENTIFICATION OF IRON-BEARING INCLUSIONS IN URANIUM METAL BY ETCHING CHARACTERISTICS. Schaich, E. L. (National Lead Co. of Ohio, Cincinnati).

A series of etchants was investigated in an effort to identify iron-bearing particles in the uranium-base dilute iron system by optical microscopy. Massive U_6Fe particles were consistently identified by color; whereas incipient particles could not be positively identified. (auth)

751 (RFP–543) A SPECIAL METALLOGRAPHIC TECHNIQUE FOR PLUTONIUM-ELECTROLYTIC SWAB ETCHING. Greeson, R. L.; Johns, W. L.; Jackson, R. J. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Oct. 1, 1965. Contract AT(29-1)-1106. 14p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A metallographic technique employing electrolytic swab etching for the structural delineation of plutonium and its alloys is described. Also presented is a discussion of the etching solutions and conditions along with photographic results which indicate the applicability of the method. (auth)

752 (RL-SEP–503) BATCH ELECTROREFINING OF PLUTONIUM METAL PROGRESS REPORT. Soine, T. S. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 26, 1965. Contract AT(45-1)-1350. 44p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

A batch electrorefining process was developed in which the time required to process a 3.5 kg batch of Pu metal was decreased from 80 to 38 hrs. This was done by increasing the electrolysis rate from about 70 to 125 g/hr, and decreasing the time required for heatup and cooldown from 30 to 8 hrs. The increased electrolysis rate was made possible by designing a new stirrer, and a new two-piece cell provided the capability of shorter heatup and cooling-off periods. Purification resulted in non-volatile impurities being less than 100 ppM in most cases. The process was completely instrumented so that it did not require attendance once the electrolysis current was started. Some difficulties with the ceramic cell were experienced. It is felt that these were solved and that the ceramic reliability should be 90% or greater. (auth)

753 (SB–415(Suppl. 1)) MOLYBDENUM AND TUNGSTEN. Price List—Selective Bibliography of Government Research Reports and Translations. (Clearinghouse for Federal Scientific and Technical Information, Springfield, Va.). 1965. 48p. CFSTI Free.

Approximately 900 references are presented on Mo and W metals, alloys, carbides, and compounds. (D.L.C.)

754 (UCRL–16121) THE MICROSTRUCTURE AND PROPERTIES OF MARTENSITE FORMED FROM CYCLICALLY TRANSFORMED AUSTENITE [Thesis]. Ravi, K. V. (Lawrence Radiation Lab., Univ. of California, Berkeley). Aug. 1965. Contract W-7405-eng-48. 59p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

By the employment of solid state transformation and thermomechanical treatments on steel, microstructures with enhanced mechanical properties have been produced. A thermo-mechanical treatment comprised of deforming the steels in the austenitic condition followed by a cyclic heat treatment of alternate heating to an elevated tempering temperature and cooling to progressively decreasing cryogenic temperatures was employed. Metallography, hardness measurements, and mechanical testing were utilized to evaluate the results of the process. The steels optimally processed had microstructures of either an essentially martensitic matrix (the high carbon steels) or a composite austenitic martensitic material that was predominately austenitic (the low carbon steel). The low carbon steel exhibited yield strengths in excess of 200,000 psi with elongation of 28 percent. Austenite instability was noted in the stress-strain curves of the high carbon steel and was not evident in the lower carbon steel. (auth)

755 (IS-Trans–20) SHRINKAGE OF POWDER COMPACTS DURING SINTERING. Kubo, Teruichiro; Shinriki, Kiichi; Kudaka, Katsuya. Translated for Ames Lab., Ames, Iowa from Kogyo Kagaku Zasshi, 61: 918-22(1958). 14p. Dep. mn; JCL $1.60 fs, $0.80 mf.

The sintering of two spherical particles is considered, and sintering formulas using the contraction as a basis were derived for the cases of viscous and plastic flow. Sintering experiments were conducted on glass, titanium oxide (rutile), nickel oxide, and barium titanate; satisfactory agreement with the formulas was obtained. (D.L.C.)

756 NUCLEAR GRAPHITE. Leveque, P. (Centre d'Etudes Nucleaires, Saclay, France). Ann. Mines, 12: 29-36(Dec. 1963). (In French).

The fabrication of nuclear graphite does not differ in principle from that of electrode graphite. A purification treatment makes it possible to obtain a graphite having a low neutron cross section. Under the effect of radiation some of the physical properties of graphite are modified. An irradiated graphite can be partially recovered by heating it to a given temperature. The radiolytic corrosion of

graphite by carbon dioxide becomes significant in the most advanced reactors of the French network. (tr-auth)

757 SURFACE IONIZATION AND SURFACE OXIDATION OF SOME RARE EARTHS ON W AND Re. Weiershausen, Walter (Universitaet, Marburg, Ger.). Ann. Physik (7), 15: 252-72(1965). (In German).

The ionization of the rare earths Nd, Sm, and Pr on W or Re was investigated in the presence of oxygen. The ionization coefficients β satisfy the Langmuir equation in the high-temperature range. The ionization energies could be estimated from their temperature dependence in this region as $I_{Nd} = 5.5 \pm 0.1$, $I_{Sm} = 6.15 \pm 0.05$, and $I_{Pr} = 5.6 \pm 0.2$ ev. At low temperatures significant deviations from the Langmuir equation were found. These were not attributed to the change of the output energy of the hot metal surface alone, as simultaneous direct measurements of the output energy confirmed. In addition to the RE metal ions, oxide ions REO^+ and only these occur. Therefore the presence of an oxidation reaction $RE + 0 \rightleftharpoons REO$ on the hot W or Re surface was assumed. Expressions for the ionization coefficients of the RE^+ and REO^+ were calculated using a simple statistical model. From the comparison of these values with the experimental values, the heats of reaction for Nd + $0 \rightleftharpoons$ NdO or Sm + $0 \rightleftharpoons$ SmO during oxidation with atomic oxygen in the gaseous phase could be calculated as 7.5 ± 0.5 and 5.1 ± 0.5 ev, respectively. Conclusions were made on the oxygen adsorption on W and Re and a method for the sensitive determination of the oxygen partial pressure was given. (tr-auth)

758 GROWTH OF UO_2 SINGLE CRYSTALS USING THE FLOATING-ZONE TECHNIQUE. Chapman, A. T.; Clark, G. W. J. Amer. Ceram. Soc., 48: 494-5(Sept. 21, 1965). (ORNL-P-1279).

A floating-zone technique for growing UO_2 crystals is described. Single crystals of UO_2 up to 2 in. long and up to $\frac{3}{8}$ in. in diameter were grown in polycrystalline UO_2 rods $\frac{1}{2}$ in. in diameter by passing a molten zone through the center of each rod. A 3- to 5-Mc, 10-kw power supply was used to produce eddy-current heating in preheated UO_2 rods. The semiconducting character of UO_2 was exploited to obtain central melting and the input power was balanced against the high radiant heat loss from the surface of the UO_2 rod to maintain a solid skin, which acted as a crucible to contain the molten center. Several advantages of the method are listed. (P.C.H.)

759 THE INFLUENCE OF SMALL WELD CRACKS ON THE FATIGUE LIFE OF STEEL PIPE FOR NUCLEAR SERVICE. Love, W. J. (General Electric Co., Schenectady, N. N.). Nucl. Struct. Eng., 2: 181-202(1965). (RL-SA-39).

An experimental program was carried out to determine the effect of small weld cracks on the fatigue strength of steel pipe. Direct and bending load tests of both innate and artificial flaws were carried out with special hydrostatic pressurization and vibratory fatigue machines. Values of notch sensitivity of the base, weld and heat affected zone materials were found to be similar, ranging between 0.1 and 0.2. The results showed that no appreciable reduction in specimen life occurred when small (to 4% wall thickness) cracks were tested in the presence of ordinary manufacturing discontinuities such as surface roughness and weld notches. A semi-empirical method for computing the influence of small pipe wall cracks on pipe life is suggested and compared with the test results. (auth)

760 THE GROWTH OF FIBER STRUCTURES FROM THE MELT. Davies, G. J. (Cambridge Univ., Eng.). pp 603-50 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965.

Controlled dendritic growth from the melt was used to produce a structure consisting of needle-like Cu_6Sn_5 fibers aligned in a ductile Cu-Sn alloy matrix. The fibers had the structure and properties of those produced by other methods and were stable in the matrix at high temperatures and/or stresses. (W.L.G.)

761 METHOD FOR THE PRODUCTION OF URANIUM BY REDUCTION OF URANIUM TETRAFLUORIDE WITH MAGNESIUM. Delnage, Maurice; Huet, Henri; Vertes, Paul (to Commissariat a l'Energie Atomique). German Patent 1,193,681. May 26, 1965. Priority date May 30, 1962, France.

Method for the production of uranium by reduction of uranium tetrafluoride with magnesium. Uranium is obtained by the reduction of uranium tetrafluoride having a density of 1.65 with Mg. The uranium tetrafluoride is produced by reducing and fluorinating uranium(IV)-oxide. Small-grained powder of uranium tetrafluoride is degassed before mixing with Mg. (Gmelin Inst.)

Corrosion

Refer also to abstract 1467.

762 (BNWL-120, pp 5.1-18) CHEMICAL METALLURGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Oxidation of Hastelloy X-280 and Haynes Alloy 25 in 10^{-4} torr dry air and oxygen atmospheres at 1120°C gave metal penetrations of 0.26 mil for Hastelloy X-280 and 0.16 mil for Haynes Alloy 25 (45 hr exposure in dry air) and 0.18 mil for Hastelloy X-250 (71 hr exposure in oxygen). The major portion of the metal penetration was due to evaporation of the alloys rather than oxidation. Spalling of the thin oxide formed on Hastelloy X-280 in an oxygen atmosphere was evident. No evidence for spalling of Haynes Alloy 25 was noticed. One 76 hr run with Hastelloy X in purified helium at 2050°F and 525 ft/sec yielded an evaporation rate of about 4 mg/cm^2. The oxidation characteristics of Zircaloy-2 were studied in a water vapor atmosphere (25 torr) at 900 to 1200°C. The kinetics for oxidation fit a parabolic rate expression $k_p(mg^2cm^{-4}min^{-1}) = 9.26 \times 10^8 \exp(-51{,}200/\text{room temp})$ applicable over the temperature range studied. The presence of hydride in the oxidized samples was also noted. It appears that hydrogen sorption occurs concurrent with the oxidation process at these high temperatures. It was confirmed that in impure helium containing H_2, H_2O, and CO, as the film thickens the H_2 absorption rate becomes faster and the oxidation rate slows down due to a pressure dependence on diffusion through the thick film. This reduction in oxidation rate means that Zircaloy process tubes will take considerably longer to reach weight gains where hydriding increases due to the thick film effect (100 mg/dm^2) than would have been predicted from high pressure data. Also, the H_2 pressure dependence data on hydriding rates are encouraging, because all data at 250 ppm H_2 indicate essentially no gas phase hydriding at any film thickness up to 450 mg/dm^2 and temperatures of 250 to 400°C. Even at 2000 ppm H_2 hydriding rates at 400°C up to 100 mg/dm^2 have been only 25% of the corrosion hydrogen. (auth)

763 (BNWL-125) CORROSION EVALUATION OF HIGH-SILICON ALUMINUM ALLOYS. Bowen, H. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1965. Contract AT(45-1)-1830. 23p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A battery of tests was performed on four high-silicon aluminum alloys containing nickel and/or magnesium to determine the best alloys for in-reactor testing. The tests included high and low flow isothermal and nonisothermal 140°C water tests, galvanic couples, stress corrosion cracking tests, and tests in 400°C steam and 360°C water. HDA-1 and -4 were decidedly superior to the other two alloys in the nonisothermal high flow, the 360°C water, and the 400°C steam tests which are considered the tests of most significance. HDA-4 had better resistance in high temperature water and is considered the most promising alloy. (auth)

764 (BNWL-SA-313) CORROSION OF ZIRCALOY-2, WEAR AND CREVICE EFFECTS. Winegardner, W. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 25, 1965. Contract AT(45-1)-1830. 6p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The localized corrosion of Zircaloy-2 by wear or fretting and crevices in the PRTR is discussed. It is concluded that wear and concentration of lithia in heated crevices can initiate localized corrosion of Zircaloy-2 reactor core components. (D.L.C.)

765 (EURAEC-1387) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 11, January 1–March 31, 1965. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Apr. 30, 1965. Contract 089-62-7 RD B. 99p. (EUR-2348). Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The oxidation of surface work-hardened type 304 stainless steel by superheated steam was studied. Metallographic examination revealed the presence of an internal oxidation zone that is related to the depth of work-hardening. Corroded samples were descaled and re-exposed to steam at 500°C for 1000 hrs. The oxidation rate was greater than that of the initial exposure, but less than that of an electropolished sample. Surface work-hardening using a pressured jet of alumina, glass pebbles, or silica slurries was evaluated. Alumina gave the best, although not adequate, results. Methods used to measure the amount of oxidation were unsuccessful due to the existence of the internal oxide layers. By using both the order of magnitude obtained from weight gain measurements and the hydrogen diffusion method, reliable corrosion values were obtained. The effects of the flow rate and surface finish on the oxidation of type 304 stainless and Creusot 1.2 MD 07 boilerplate steels by water at 300°C and 150 kg/cm^2 were measured. The electropolished stainless was the most corrosion resistant surface finish at 2 m/sec, but the surface finish effect disappeared at 10 m/sec. The thickness of the oxide layer on the boilerplate steel remained constant at both flow rates, but the amount of dissolved metal in the water increased. (W.L.G.)

766 (EURAEC–1445) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 12, April 1–June 30, 1965. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). July 31, 1965. Contract 089-62-7 RD B. 146p. (EUR–2379). Dep. mn; CFSTI $4.00 cy, $1.00 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The oxidation rate of type 304 stainless steel in steam at 500°C was found to be proportional to the depth of surface work-hardening. Four different methods of work-hardening were evaluated. In order of decreasing corrosion protection, they were: milling, grinding, mechanical polishing, and electropolishing. Corrosion resistance comparable to mechanical polishing was produced by either grit-blasting with an alumina slurry or chromizing the surface. Metallographic examinations of heat treated type 410 stainless steel confirmed the existence of an internal oxide corrosion layer. Corroded stainless steel samples, which were initially exposed to steam at 600°C, were descaled and re-exposed to steam at 500°C. The prior corrosion protection due to surface work-hardening was absent. The surface finish of type 410 stainless steel appears to have little effect on its rate of oxidation by water. The corrosion rate of stainless steel was at a maximum value at 250°C and is related to the large quantity of metal dissolving in the water. As this phenomena was not observed with boilerplate steel, the solubility was attributed to the chromium content. Excluding electropolished samples, the oxidation rate of type 304 stainless steel was independent of the water flow rate. A method for the determination of hydrogen in Zircaloy-2 using the vacuum extraction principle is described. (W.L.G.)

767 (GEAP–4915) STAINLESS STEEL FAILURE INVESTIGATION PROGRAM. First Quarterly Progress Report, February 15–June 30, 1965. Pashos, T. J. (comp.) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1, 1965. Contract AT(04-3)-189. 58p. (EURAEC–1470). Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

A number of type 304 stainless steel clad fuel rods operating in boiling water reactor environments have failed due to intergranular cracking. Factors that may affect intergranular cracking of austenitic stainless steels are discussed and the research program proposed is described. The program consists of the investigation of the effects of material composition, coolant environment, irradiation damage, and operating stresses on clad cracking. In preliminary corrosion tests, high purity stainless steels proved more corrosion resistant than type 304 stainless steel. Intergranular attack was produced by boiling HNO_3 + Cr^{6+} solutions, transgranular attack by boiling $MgCl_2$ solutions, and either transgranular or intergranular in $FeCl_3$ solutions at 343°C depending on test variables. A cladding specimen section through a region of localized strain revealed an incipient intergranular crack starting on the outside surface and extending ~6 mils across the 14 mil cladding thickness. Eighty-four references on intergranular cracking in austenitic stainless steel are included. (W.L.G.)

768 (NASA-CR–54226) EVALUATION OF HIGH STRENGTH COLUMBIUM ALLOYS FOR ALKALI METAL CONTAINMENT. Interim Report No. 2 Covering the Period July 25, 1962 to July 10, 1964. Engel, L. B. Jr.; Frank, R. G. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Contract NAS 3-2140. 116p.

Corrosion testing of AS-55, Nb–1 Zr and D-43 alloy reflux capsules containing purified K was conducted at 2000°F for 5000 hrs in an ultrahigh vacuum chamber. A vacuum in the 10^{-6} torr range was maintained throughout the test. The condensing rate of the K contained within the 1-in. dia × 11-in. long capsules was approximately 37 ± 12 lbs/hr/ft^2 at 2000°F. Evaluation of two capsules, AS-55 alloy and Nb–1 Zr alloy, after the 5000-hr exposure revealed only a very slight amount of general corrosion. This was evidenced by some solutioning and the presence of dark stains visible at the liquid-vapor interface and other locations. However, an improved transfer system was used in filling the second AS-55 alloy and the D-43 alloy capsules with K and no signs of staining were observed in either capsule after the 5000-hr exposure. Also, the improved transfer system provided the first reasonable agreement of O_2 analysis between the Hg amalgamation techniques (33 to 50 ppM) and the Zr-getter method (22 ppM). A very small amount of white, non-metallic deposit, which is believed to be Y_2O_3, was observed in the AS-55 alloy capsule. No attack of grain boundaries in either the weldments or recrystallized sheet was observed in any of the alloys. Although some coalescence of the carbides appears to have occurred in the AS-55 alloy, stress-rupture testing of specimens machined from the capsule wall after the 5000-hr, 2000°F test exposure indicates no loss in strength as a result of the exposure to K. Chemical analyses of samples obtained from the capsule walls revealed no mass transfer of C in either the AS-55 or D-43 alloys. However, the results of the chemical analysis of all three alloys provides an indication that O_2 is leached from material high in O_2 by the K condensate. Similar capsule testing for a time period of 10,000 hours was conducted on AS-55, Nb–1 Zr and D-43 alloys. No visual signs of gross corrosion are apparent. (auth)

769 (NASA-CR–54459) CAVITATION DAMAGE IN LIQUID METALS. Technical Progress Report, April 1–May 31, 1965. Thiruvengadam, A.; Preiser, H. S.; Rudy, S. L. (Hydronautics, Inc., Laurel, Md.). June 30, 1965. Contract NAS 3-4172. 27p. (TPR–467-3).

Cavitation damage resistance of Stellite 6B, type 316 stainless steel, Cb-132M, TZM and T-222 in liquid Na at 400, 1000, and 1500°F is reported. The test duration is an important parameter in evaluating their relative resistance. Stellite 6B exhibited the best resistance among the metals tested. High frequency fatigue results for type 316 stain-

less steel and TZM in liquid Na at 1000 and 1500°F are presented. The fatigue of type 316 stainless steel in 1500°F Na at 14000 cps is compared with the results obtained in 1500°F vacuum (3×10^{-5} torr) at 4-5 cps and there appears to be good agreement between these results. No stress corrosion cracking of type 316 stainless steel was observed in 1000°F Na up to 100% yield over a test period of 60 hours. (auth)

770 (NASA-CR-54477) ADVANCED REFRACTORY ALLOY CORROSION LOOP PROGRAM. Quarterly Progress Report No. 1, April 15, 1965–July 15, 1965. Harrison, R. W. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). July 21, 1965. Contract NAS 3-6474. 12p.

Material procurement and specifications are described and the design and room temperature compressive properties of Nb–1 Zr and T-111 alloy valve bellows having 15 convolutions are given. (W.L.G.)

771 (NP-15558) ULTRASONIC-INDUCED CAVITATION STUDIES IN LEAD–BISMUTH ALLOY AT ELEVATED TEMPERATURES. Internal Report No. 05031-4-I. Garcia, R.; Hammitt, F. G. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Sept. 1965. 40p.

Cavitation studies were conducted in 70% lead–30% bismuth alloy at 500°F and at 1500°F with a vibratory device utilizing a piezoelectric crystal transducer unit and high-temperature cavitation facility. The test materials that were subjected to the cavitation environment were Types 304 and 316 stainless steel, two tantalum alloys, Mo–1/2Ti, and Nb–1Zr in two heat-treat conditions. At 500°F, the tantalum alloys were the most cavitation-resistant based on mean depth of penetration, although the Mo–1/2Ti, and the two stainless steels were nearly as good. At 1500°F, both tantalum alloys were still the best, followed by Mo–1/2Ti, Nb–1Zr (cold-worked), and 316 stainless steel in that order. The Nb–1Zr (annealed) and 304 stainless steel were the least cavitation resistant. Thus, as expected, the relative advantage of the refractory alloys at high temperature is indicated. For all materials, the cavitation damage at 1500°F was substantially greater than that at 500°F, as expected. Qualitative and quantitative correlations between the cavitation damage data and the mechanical properties of the materials are presented. (auth)

772 (NYO-3257-1) THE STRESS CORROSION SUSCEPTIBILITY OF HIGH STRENGTH STEELS. Final Report. Hoke, John H. (Pennsylvania State Univ., University Park. Mineral Industries Experiment Station). June 1965. Contract AT(30-1)-3257. 65p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

A study was made of stress-hydrogen cracking problems for type 410 stainless steel. The results show that a general correlation exists between resistance to stress hydrogen cracking and notch sensitivity. However, considerable variability in behavior is possible in apparently similar materials and direct conversion of impact data to stress-hydrogen cracking susceptibility is not reliable. Thermal treatments which increase fracture toughness also increase resistance to stress-hydrogen cracking. High-purity vacuum-melted alloys have much higher resistance to stress hydrogen cracking than commercial air-melted alloys. The specific ingredients present responsible for such degradation are not known, but general steel making alloy additions may contribute in part. (D.L.C.)

773 (ORNL-3859) SNAP-8 CORROSION PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1965. Savage, H. W.; Compere, E. L.; MacPherson, R. E.; Huntley, W. R.; Taboada, A. (Oak Ridge National Lab., Tenn.). Sept. 1965. Contract W-7405-eng-26. 22p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Operation of the final loop (14-4) in the present phase of the corrosion program with continuous cold trapping and deuterium injection was completed. The objectives were to ascertain differences in corrosion and mass transfer rates resulting from continuous cold trapping and to evaluate the effectiveness of cold trapping in reducing the H_2 concentration in the NaK and thus the H_2 effluent from the loop. The loop operated for 2659 hr at design temperature prior to shutdown. The hydride trap for collecting extraneous H_2 operated for 500 hr, and the deuterium trap operated for 676 hr. The introduction of deuterium into the loop successfully served to distinguish between extraneous H_2 and that injected into the loop. The deuterium data indicated that the equilibrium pressure in the loop is approximately the same as the calculated H_2 partial pressure for the SNAP-8 primary system in space (2.4×10^{-5} atm). Results of analytical examinations on all but loop 14-4 generally confirmed previous observations. Very little metal migration occurred in low-O_2 content NaK at both temperature levels investigated; however, C migration was severe. Corrosion of the Fe-base alloys in the low-O_2 content NaK was very low, as compared with corrosion of the chromized Hastelloy N, which ranged from three to seven times as great. Sheet tensile specimens of Croloy 9M were decarburized to a C content of approximately 0.002 to 0.01%. As shown previously, there was general deterioration of mechanical properties. (J.R.D.)

774 (RFP-609) OBSERVATIONS ON THE ATMOSPHERIC OXIDATION OF PLUTONIUM METAL. Thompson, M. A. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). [1963]. Contract AT(29-1)-1106. 20p. (CONF-651102-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Royal Commonwealth Society, 3rd International Conference on Plutonium, London.

The effects of temperature, pressure, and moisture on the atmospheric oxidation of plutonium metal were investigated. Changes in the slope and a discontinuity were confirmed in the oxidation rate curve at temperatures of the plutonium phase transformations. The minimum in the rate curve near 400°C was reconfirmed. Properties of the oxide and metal possibly contributing to the anomalous oxidation behavior are considered. (auth)

775 (SRIA-425-6, pp 10-33) INTERACTION OF NIOBIUM WITH NITROGEN AND WITH OXYGEN AT VERY LOW PRESSURES. Pasternak, R. A. (Stanford Research Inst., Menlo Park, Calif.). (CONF-650617-4).

From Vacuum Metallurgy Conference, New York.

Ultrahigh vacuum techniques were used in an attempt to elucidate the adsorption and solution mechanisms at low pressures. Pressures of 5×10^{-9} to 1×10^{-5} torr were used at 25 to 1800°C. A summary is presented of the results. (D.L.C.)

776 (TIM-822) THE COMPATIBILITY OF COMPACTED BORON CARBIDE IN STAINLESS STEEL–ALKALI METAL SYSTEMS. Lymperes, C. J.; Slotnick, H. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). July 27, 1965. Contract AT(30-1)-2789. 10p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Specimens of boron carbide were exposed to 1000°F NaK-78 for extended times exceeding 5000 hours. Results of test indicate the strong likelihood that the carbide would fragment in 1000°F NaK-78. It was noted that the fragments could be retained by 20 and 160 micron sintered metal filters. Fragmentation is attributed to the reaction between potassium and free carbon. Although boron and carbon transfer occurred, reaction between boron carbide and type 316 in NaK-77 was not detrimental. (auth)

777 PRELIMINARY EXPERIMENTS ON THE INFLUENCE OF THE ORGANIC CHLORINE CONTENT IN TERPHENYL ON IRON CORROSION, IRON TRANSPORT AND POSSIBLE RELATIONSHIP WITH THE FORMATION OF FOULING. Bordonali, C.; Brignocchi, A.; Recrosio, A. (CNEN, Rome). Energia Nucl. (Milan), 12: 538-48(Oct. 1965).

The possible influence of the organic chlorine content in terphenyl on the formation of fouling is discussed. Results over the following tests are given: corrosion of iron immersed in terphenyl containing various amounts of chlorine and water; pyrolysis, hydrolysis, and radiolysis of chlorobenzene; solubility of ferrous chloride in terphenyl; an adsorption of chlorinated organic compounds, ferrous chlo-

ride, and hydrogen chloride on Attapulgus Clay AARVM. (auth)

778 THE STRUCTURE OF OXIDE FILMS FORMED ON THE Zr SURFACE. Nakayama, Tadayuki; Koizumi, Tatsuya (Waseda Univ., Tokyo). Nippon Kinzoku Gakkaishi, 29: 472-8(1965). (In Japanese).

The structure of thin oxide films formed on Zr surfaces under various conditions was studied by electron microscopy and electron diffraction. The oxide films formed by dry oxidation, e.g., heating in air at 300 to 500°C or dipping in a fused salt bath (50 g $NaNO_3$, 50 g KNO_3, 1 g MnO_2: 400°C), consisted of only the monoclinic ZrO_2. Regularly aligned lines about 2500 Å in length were observed in some oxide films formed on the surfaces smoothed by cloth polishing. Tetragonal ZrO_2 as well as the monoclinic ZrO_2 was detected in Zr oxide films produced by wet oxidation such as immersing in boiling concentrated HNO_3. On the hydrogen-absorbed surfaces by either cathodizing in 5% H_2SO_4 or immersing in 35% HCl, oxide films composed of tetragonal and monoclinic ZrO_2 crystals were produced by dry oxidation. When the Zr specimen was quenched in water after heating in air at 400°C, the surface was covered with both tetragonal and monoclinic ZrO_2 crystals. Tetragonal ZrO_2 in the oxide films produced by wet oxidation transformed to monoclinic ZrO_2 on heating in air above 1150°C. These results indicated that metastable tetragonal ZrO_2 crystals are produced in oxide films partly due to the existence of water or hydrogen in oxidizing atmosphere. (auth)

779 MICROSTRUCTURAL ASPECTS OF STRESS-CORROSION FAILURE. Swann, P. R.; Embury, J. D. (United States Steel Corp., Monroeville, Pa.). pp 327-62 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965

Electron microscope studies of many alloys susceptible to transgranular stress-corrosion cracking show that tunnel corrosion is the characteristic mode of attack by environments which cause cracking. Also, the rates of crack propagation compare well with measured growth rate of tunneling. These observations support the mechanism that cracking propagates by the ductile rupture of a slot weakened by many tubular corrosion pits lying in the crack plane. This explains the correlation between coarse slip and stress-corrosion cracking since surface films are more likely to be ruptured by coarse slip occurring during exposure to stress-corrosion cracking environments. The slip step height of deformed dilute alloys is small and less likely to cause intense local damage to surface films, therefore, these alloys exhibit resistance to transgranular cracking. The applied stress in transgranular stress-corrosion cracking does not produce elastic stress concentrations, but produces localized plastic strain necessary for film rupture. The properties of the stress corrosion environment that are considered important in the nucleation of transgranular stress corrosion cracks are: a surface film must form over most of the alloy surface, the environment must be able to support tunnel corrosion, the mechanical properties and thickness of the film must be such that it can be ruptured by slip, and the repair rate of the surface film must be slow enough, and the creep rate of the specimen fast enough, for the environmental conditions necessary for tunnel corrosion to be established at the exposed slip step. (W.L.G.)

780 KINETICS OF THE OXIDATION OF TANTALUM AT HIGH TEMPERATURES AND LOW OXYGEN POTENTIALS [Thesis]. Adelsberg, Lee Martin. Columbus, Ohio, Ohio State Univ., 1964. 86p.

A new model was developed to describe the paralinear oxidation behavior of tantalum in water vapor at temperatures in the range of 840 to 1250°C. The model was found to be consistent with a series of experiments conducted by others. It provided a method for estimating the diffusion coefficient of oxygen ion vacancies in Ta_2O_5. A value of $D^{Ta_2O_5}_{O^=} = 0.027 \exp -(50{,}000/RT\ cm^2/sec)$ was obtained. The value of the frequency factor, K, was virtually independent of temperature and was found to be 0.015 exp −(1350/RT cm/sec). The oxide scale which formed during the reaction was found to be Ta_2O_5 only. It was also determined that the Ta_2O_5 cracked during the reaction. The oxide platelets which have been observed in the tantalum, adjacent to the metal-oxide interface, formed on cooling, and were identified to be Ta_4O. (Dissertation Abstr.)

Fabrication

Refer also to abstracts 1277 and 1556.

781 (AI-65-12) DEVELOPMENT OF A MAGNEFORMING PROCESS FOR THE FABRICATION OF THIN-WALL TUNGSTEN CYLINDERS. Final Report. Abraham, L.; Katz, N. H.; Supan, E. C. (Atomics International, Canoga Park, Calif.). Jan. 13, 1965. Contract NAS 3-5211. 37p. (NASA-CR-54316).

Tungsten powders were consolidated into thin-wall cylinders in a die that compacted the powders at elevated temperature, by virtue of the differences in thermal expansion between the die body and mandrel materials. Feasibility of using this consolidation method as a cylinder preforming process was demonstrated, and densities up to 75% of theoretical were obtained. Consolidated cylinders were formed at 1800°C and further densified by Magneforming. Magneforming, a high-energy-rate metal-forming technique, was adapted to high-temperature, vacuum-atmosphere operating conditions. Special tooling and methods were developed to enable metal-forming operations to be carried out at temperatures as high as 1427°C. Presintered thin-wall tungsten cylinder preforms were densified an additional 5 to 10% by this method, but cracked during a subsequent leaching step, which is required to release the cylinders from the Magneform workpiece assembly. Equipment, methods, and results are described, and process recommendations are made. (auth)

782 (DP-943) THORIUM-1.4 percent ^{235}U METAL FUEL TUBES—FABRICATION AND IRRADIATION IN HWCTR. Nemeth, Stephen R. (ed.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1965. Contract AT(07-2)-1. 30p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Three Th−1.4 wt % ^{235}U alloy fuel tubes with Zircaloy-2 cladding were fabricated. Two of the tubes were irradiated in HWCTR to an exposure of 3500 Mwd/te without failure. The development of a coextrusion process for fabrication and the results of the irradiation of the tubes in the HWCTR are described. (auth)

783 (IS-1227) PNEUMATIC-MECHANICAL HIGH-ENERGY-RATE EXTRUSION OF YTTRIUM. Owen, C. V.; Scott, T. E.; Carlson, O. N. (Ames Lab., Iowa State Univ. of Science and Tech.). Aug. 1965. Contract W-7405-eng-82. 55p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The high-energy-rate (H.E.R.) extrusion characteristics of two grades of yttrium metal were studied. Anomalies observed in the extrusion behavior are discussed. Conditions for satisfactory extrusion by the H.E.R. process were determined. Tensile properties of the as-extruded rods are presented. (auth)

784 (NLCO-965, pp 3.1-5) CONTROLLING FURNACE CYCLE WITH INFRARED PYROMETERS IN CASTING URANIUM INGOTS. Brodi, G.; Abbott, A. (National Lead Co. of Ohio, Cincinnati).

Fourteen-hundred-pound melts were monitored during a test program by infrared radiation pyrometers mounted on two production remelt furnaces. The pyrometers were sighted on the crucible pour plug and then on the uranium pour stream as the ingot was cast. Ingots cast by the standard melting cycle (power-time) were compared with ingots produced by terminating the melting cycle according to a predetermined reading of the pyrometer. (auth)

785 (NLCO-965, pp 5.1-10) INDUCTION AND SALT HEAT TREATING OF SOLID AND HOLLOW OIL-

QUENCHED HAPO CORE BLANKS. Bauer, R. F. (National Lead Co. of Ohio, Cincinnati).

Solid and hollow uranium core blanks were heated both by induction and in molten salt and quenched in oil. Photomacrographs revealed satisfactory structures for blanks heat treated both solid and hollow using either heating medium with oil as the quenchant. (auth)

786 (ORNL-TM-1252) BRAZING FLANGES TO SINTERED, STAINLESS STEEL FILTERS FOR HIGH-TEMPERATURE SERVICE. Donnelly, R. G. (Oak Ridge National Lab., Tenn.). Oct. 1965. Contract W-7405-eng-26. 10p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A procedure was developed to successfully join wrought, type 347 stainless steel flanges to sintered filters of the same alloy for service at 1300°F. The procedure consisted of presealing the joint area of the filter with a high-melting nickel-base brazing alloy and then, in a second brazing operation with a lower melting alloy, joining the flange to the presealed filter. This double brazing operation was necessary to overcome the gross absorption of brazing alloy by the sintered filter due to capillarity. Sealing of the filter joint area was accomplished by coating with a controlled quantity of the Standard Nicrobraz alloy (AMS-4775) and vacuum brazing at 2150°F for 5 min. The flange was then joined to the filter by induction brazing in an argon atmosphere with two rings of Premabraze 130 (82% Au–18% Ni, melting point 1742°F). Metallographic examination revealed that this procedure caused no detrimental effects to the filter's properties. To date, through utilization of the developed procedure, seventeen type 347 stainless steel filters have been successfully joined to wrought flanges of the same alloy. (auth)

787 (RFP-623) HOT EXTRUSION OF FINE PLUTONIUM WIRE. Beer, B. J.; Fischer, R. B. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Sept. 27, 1965. Contract AT(29-1)-1106. 8p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Unalloyed plutonium wire with a diameter of 0.017 in. was extruded from a 0.170 in. diameter plutonium billet heated to about 230°C. The extrusion process did not appear to influence the ductility of the plutonium; i.e., the resulting alpha wire appeared brittle. The grains in the wire did not appear to be elongated as a result of the extrusion process. (D.L.C.)

788 (SWRI-1228-73) METALLURGICAL EVALUATION OF THE LACBWR FORCED CIRCULATION CLAD PIPING. Wylie, R. D.; McDonald, Jose; Speirs, K. K.; Watson, P. D. (Southwest Research Inst., San Antonio, Tex.). Aug. 24, 1965. Contract AT(11-1)-1228. 80p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The material for the LaCrosse Boiling Water Reactor Forced Circulation Piping System is carbon steel (A212 Grade B) clad with austenitic (Type 304) stainless steel. Problems were encountered during the fabrication of the piping, and investigations were conducted to form a basis for acceptance of the clad pipe. The quality assurance program is given, and the repair and examination of clad pipe welds are described. (D.L.C.)

789 (AD-619333) SPOT WELDING OF NIOBIUM. Grishin, V. L.; Grishina, A. D. Translated from Tsvetn. Metal., 37: 67-8(1964). 7p. (FTD-TT-65-613). CFSTI.

Prewelding surface preparation of the 0.1, 0.3, and 0.5 mm thick sheets consisted of degreasing in acetone, deburring with emory sandpaper, and washing in alcohol. Application of a thin layer of graphite to the Nb surface reduced the adhesion of the electrode to the surface. The operating parameters for the TKM-6 percussion spot welder are given. (W.L.G.)

790 THE NUCLEAR PILOT GRAPHITE PLANT OF JEN. Otero de la Gandara, J. L.; Ortiz de la Torre, J. L.; Mendez Penalosa, R. Energia Nucl. (Madrid), 9: 4-11 (1965). (In Spanish).

The pilot plant for the production of nuclear graphite performs the following services: storage of the primary materials, milling, sieving, mixing, pressing, annealing, impregnation, and graphitization. Ventilation and mechanization are discussed. Each of the installations and services is described. The work done in the plant is reviewed. (J.S.R.)

791 PROBLEMS AND EXPERIENCE IN PRODUCING CAST URANIUM CARBIDE RODS. Schaefer, L. (NUKEM, Wolfgang, Ger.). Kerntechnik, 7: 359-61(Aug.-Sept. 1965). (In German).

Cast natural uranium monocarbide rods were produced for the critical experiment Orgel (ECO). Skull-melting in an arc furnace and tilt pouring were the techniques used for the fabrication of the rods while the melting stock was produced in a semicontinuous vacuum-induction furnace by the carbothermic reduction of UO_2. The processes applied proved to be suitable for production purposes. Experience showed that the carbon content can be kept within ±0.1 wt. % of a specified value. The (oxygen + nitrogen) value stayed below 600 ppm. Difficulties encountered were instabilities of the arc and cracking of cast rods. The instabilities of the arc that caused bad yields by uncontrolled casting conditions were prevented by a special crucible construction. The cracking problem, which only appeared in casting rods with diameters larger than 25 mm, could not be solved completely. Melting under lower pressure reduced cracking. Grinding of the rods required by the customer could be carried out without difficulty. The grinding scrap to be chemically recycled for casting rods with a diameter of 25 mm equaled to 8 percent of the material charged in the furnace. (auth)

792 PRODUCTION OF SMALL URANIUM CARBIDE SPHERES FROM MELTS AND MELT SUSPENSIONS. Knotik, K.; Bildstein, H.; Koss, P. (Reaktorzentrum, Seibersdorf, Austria). Kerntechnik, 7: 361-5(Aug.-Sept. 1965). (In German).

Known methods for production of small uranium carbide spheres are reviewed. A description of two methods allowing the direct production of particles from oxide-carbon suspensions in paraffin melts or melted salts is given. (auth)

793 THE POWDER-AGGLOMERATION METHOD FOR THE FABRICATION OF SPHERICAL FUEL PARTICLES. Huet, J.-J.; Gorle, F. (C.E.N., Mol, Belg.). Kerntechnik, 7: 365-7(Aug.-Sept. 1965).

Powder agglomeration methods are applied in the fabrication of spherical particles for nuclear reactor fuel. The right choice of raw materials, binder, and equipment makes it possible to produce spherical particles of very good quality, from oxides and carbides of thorium, uranium, plutonium, zirconium, and mixtures of these compounds. In the case of the carbides, it was found to be more adequate to start from the oxides and a sufficient amount of carbon. The reduction takes place inside the particle itself by means of a high-temperature high-vacuum heat treatment. The powder agglomeration method proved to be versatile; it allows the chemical composition to be adjusted independently of melting points and of liquid or solid miscibility of the different materials involved. (auth)

794 NON-DESTRUCTIVE TESTING OF FUEL RODS. Libotte, P. (Belgo Nucleaire, Brussels). Kerntechnik, 7: 373-5(Aug.-Sept. 1965).

Tests performed on finished fuel rods cover cladding, fuel powder, and welds. The purpose of the cladding tests is to control the dimensions and to detect internal and external cracks. The fuel powder is checked with regard to average density and axial variations, the plutonium longitudinal distribution, and the fuel length. Tests on the welds are performed in order to verify tightness, depth of penetration, absence of gas bubbles, inclusions, cracks, etc. Special techniques were developed for cladding crack detection, determination of the density longitudinal distribution, and determination of the plutonium longitudinal distribution. Cracks of the order of 10 μm are detected by use of reflected waves technique. The density variations are determined by use of an external gamma source. The fuel rods are densified by vibration of three size fractions of which

only the fine fraction contains plutonium. Counting of the gamma radiation emitted by the plutonium gave the distribution of plutonium with a precision of ±4%. (auth)

795 PROPOSED STANDARD QUALITY CONTROL FOR PLATE-TYPE URANIUM-ALUMINUM FUEL ELEMENTS. Nucl. Eng. Bull., 3: 4-6(Aug. 1965).

Minimum quality control requirements for manufacture of plate-type Al-U fuel elements proposed are outlined. The Al-U alloy is clad with aluminum. Methods, procedures, techniques, and other requirements for inspection and quality control are described. (M.C.G.)

796 A TECHNIQUE FOR EXTRUSION FORMING OF BRITTLE AND REFRACTORY COMPOSITIONS. Pickus, Milton R.; Wells, Molly (Univ. of California, Berkeley). Powder Met., 8: 351-65(1965). (UCRL-16111).

A number of compounds of transition-group metals with carbon, nitrogen, boron, and silicon were found to exhibit high values of the superconducting parameters, critical temperature and critical magnetic field strength. As a group, these compounds are characterized by high melting points and extreme brittleness, and hence require special fabricating techniques. A brief description is given of an extrusion method for their fabrication. A powdered material, either metallic or not, is coated with polystyrene in such a manner and proportion that the mixture as a whole takes on the characteristics of a typical thermoplastic. The preparation may then be subjected to the forming methods commonly employed with plastics, such as molding, extruding, and hot forming. Brittle materials may thus be obtained in the form of rod, ribbon, or wire. These products are next subjected to a programmed heating cycle in an appropriate atmosphere, during the course of which the polystyrene is volatilized, and sintering of the powdered material takes place with retention of the original shape. Under favorable conditions, sintering may proceed to a point where near-theoretical densities are attained. Among the materials processed by this method are the carbides of tantalum and niobium, carbo-nitrides of niobium, tungsten carbide/cobalt mixtures, and aluminum oxide. (auth)

797 METALLOGRAPHIC PREPARATION OF NUCLEAR FUEL PARTICLES. Boerner, Gudrun; Goergenyi, Tibor; Huschka, Hans; Schinzer, Friedhelm (NUKEM, Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). Prakt. Metallog., 2: 171-6(Aug. 1965). (In German).

Methods are described for grinding, polishing, and etching of pyrolytic carbon-coated UC_2 particles, as well as for determination of the microhardness of PyC coatings. For the determination of the coating thickness and the reaction zone between UC_2 particles and PyC coatings a microradiographic method is described. (auth)

798 IMPROVEMENT OF THE MELTING WITHOUT CRUCIBLE TECHNIQUE, FOR REFRACTORY OXIDES. PREPARATION OF DENSE AND HOMOGENEOUS SAMPLES OF STABILIZED ZIRCONIA. Deportes, Charles; Lorang, Bernard; Vitter, Gerard (Univ. Paris, Grenoble, France). Rev. Hautes Temp. Refractaires, 2: 159-61 (Apr.-June 1965). (In French).

Different modifications brought to melting without crucible techniques made it possible to obtain dense, homogeneous, and nonporous samples of calcia-stabilized and yttria-stabilized zirconia. The process also allowed the measurement of melting points of refractory samples. This process is available for all oxides or oxide mixtures the conductivity of which is high enough to have them melt without a crucible. (auth)

799 PREPARATION AND HOT PRESSING OF URANIUM MONONITRIDE. Thuemmler, Fritz; Ondracek, Gerhard; Dalal, Kirit (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 56: 535-42(Aug. 1965). (In German).

Data on uraniummononitrid (UN) are summarized. UN-Powder (42 μm diam) can be produced by a nitrogen treatment (25 Torr N_2 over atmospheric pressure, 850°C, 2 hours) of metallic uranium and subsequent decomposition (10^{-5} Torr, 1150°C, 1.5 hr) of the U_2N_3 obtained by the first treatment. The UN was pressure-sintered in graphite dies. Relationships between the density of the sintered specimen and the time (about 30 min) and temperature (1370–1678°C) of sintering and pressure were established. In most cases maximum density was reached after a relatively short time (about 18 min). The temperature dependence of the final density showed a maximum, which is due to grain growth above 1500°C. The density of the sintered specimens (about 80%) increases with pressure but is not very high in all cases. With milled UN-powders of 1 μm diameter a density of about 87% was achieved. A further increase is possible due to postannealing treatment (10^{-5} Torr, 1700°C, 2 h). Small additions of other materials (nickel, carbonyl iron, UAl_2) lead to a small increase in density only in the case of nickel. Under the chosen conditions there is no large reaction between the UN and the carbon of the die. The maximum carbon content of the sintered specimen was 0.44 wt %. The oxygen content is less than that of the powder. Microhardness measurements scattered between 533 and 734 DPH. 151 references are cited. (auth)

800 SPECIFICATIONS FOR WELDING AUSTENITIC STAINLESS STEEL (Engineering Materials). (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). (CAPE-1080).

4 specs.

Welding specifications, control standards, and radiographic technique requirements used in manual welding of austenitic stainless steel in nuclear reactor experiment systems are presented. The welding specifications cover tungsten-inert gas process welding and combined tungsten-inert gas and shielded metal-arc welding of steel tubes, pipes, and fittings. The maximum weld metal thickness is 0.75 in. Qualification procedures are included, which will permit operators to obtain approval to weld austenitic stainless steel tubes, pipes, and fittings. The control standards include requirements used in inspecting piping welds, and supplementary requirements to existing welding codes. Radiographic technique requirements are included for the inspection of piping welds. (For details, see TID-4100) (M.C.G.)

801 METHOD FOR THE PRODUCTION OF A MATERIAL BASED ON MAGNESIUM FOR NUCLEAR REACTOR PARTS. Emley, Eward Frederick (to Magnesium Elektron Ltd.). German Patent 1,192,828. May 13, 1965. Priority date Aug. 11, 1961, Great Britain.

A material for nuclear reactor parts is obtained from a magnesium alloy containing 0.1 to 1% Zr, and optionally 0.25% Mn and/or 0.01% Be, by compacting powder of this alloy by means of hot-working. (Gmelin Inst.)

802 COATED METALLIC URANIUM ARTICLE AND METHOD OF MAKING. Eubank, Lowell D. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,628. Oct. 12, 1965.

A process of bonding aluminum sheaths to nuclear uranium fuel elements with aluminum–silicon alloy is discussed, and it also covers so-canned fuel. (AEC)

803 URANIUM MONONITRIDE FUEL AND METHOD OF MAKING. Endebrock, Roy W. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,664. Oct. 12, 1965.

Uranium mononitride containing throughout randomly dispersed nitrides of titanium, and a method for producing the same comprising reacting an alloy consisting of from about 5 to about 20 weight percent titanium and the balance uranium with elemental nitrogen under pressure of about 5 atmospheres in an electric arc is discussed. (AEC)

804 METHOD OF MAKING NUCLEAR FUEL COMPACT. Johnson, Dale E.; Lofftus, Fred H. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,812. Oct. 12, 1965.

A method of making nuclear fuel bodies wherein particles of a nuclear fuel oxide, carbide or silicide are evenly distributed throughout a matrix of refractory material is described. The fuel particles are coated with a layer of desired size of a refractory, i.e., alumina, beryllia, aluminum

carbide, or beryllium carbide, a body formed substantially entirely from the coated particles and the body thereafter sintered to produce a dense, thermally conductive fuel body. (AEC)

805 CANNING MACHINE. Boller, Ernest R. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,884. Oct. 12, 1965.

A rod canning machine is proposed. The machine consists of a means for supporting cans during the canning process, maintaining thermostatically controlled temperatures within the can supporting element and around the plunger in its elevated position, inserting the rod into the can, preheating the can cap while attached to the plunger in its elevated position, applying the cap to the can, fusing the can to the rod by means of a metallic bond, and ejecting the can by plunger action into a cooling liquid. (AEC)

806 PROCESS FOR SINTERING URANIUM NITRIDE WITH A SINTERING AID DEPRESSANT. Hammond J. P. (to U. S. Atomic Energy Commission). U. S. Patent 3,213,032. Oct. 19, 1965.

A method is given for preparing a densified compact of uranium nitride which comprises uniformly mixing uranium nitride powder with an effective amount of a uranium intermetallic compound, pressing said mixture to a desired green strength and then sintering the resulting compact at a temperature in the range 1400-1800°C. (AEC)

807 PROCESS FOR FORMING A URANIUM MONONITRIDE-URANIUM DIOXIDE NUCLEAR FUEL. Craig, Richard A. (to U. S. Atomic Energy Commission). U. S. Patent 3,213,161. Oct. 19, 1965.

The method of producing nuclear fuel is described according to which a small quantity of uranium dioxide is added to uranium mononitride prior to sintering to produce fuel pellets. The uranium dioxide thus added inhibits grain grown of the nitride at high temperatures and results in a product of greater density than that of sintered uranium mononitride. (AEC)

808 METHOD OF MAKING NUCLEAR FUEL COMPACT. Johnson, Dale E.; Lofftus, F. H. (to U. S. Atomic Energy Commission). U. S. Patent 3,213,162. Oct. 19, 1965.

A method of making a high-temperature ceramic fuel body is considered wherein particles of the oxides, carbides or silicides of nuclear fuel metal are pressed with a binder to form a green compact, the compact is coated with a slurry comprising a refractory material selected from alumina, beryllia, aluminum carbide, beryllium carbide or mixture thereof, and a liquid carrier which is a nonsolvent for the binder, and thereafter sintering the coated compact to a dense, thermally conductive, high-temperature ceramic fuel body. (AEC)

809 FABRICATION OF SHAPES BY PNEUMATIC IMPACTION. Brite, Daniel W.; Sump, Kenneth R. (to U. S. Atomic Energy Commission). U. S. Patent 3,213,163. Oct. 19, 1965.

A method of forming a nuclear-fuel element of the grid type from a cermet is described. A mixture of ceramic and metal powders is placed in a ductile metal mold that is provided with spaced posts or mandrels that are so spaced that the open area between them has the general shape of the desired grid. The mold is confined within a die and subjected to a high impact-producing pressure. The impact is applied longitudinally to the posts, compressing them longitudinally and expanding them laterally. The powder mixture is compressed in all directions and compacted into a solid cermet. The mold is then removed by being dissolved in a reagent that does not attack the oxides of the metal or the cermet. (AEC)

Properties and Structure

Refer also to abstract 1344.

810 (AERE-R-5011) STUDIES OF THE EQUILIBRIUM METAL VAPOUR PRESSURES OVER THE ALKALINE-EARTH CARBIDES. Flowers, R. H.; Rauh, E. G. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 21p. Dep.; BIS $0.60, 3s. 0d.

SrC_2 and BaC_2 were synthesized in a state of high purity, and, using both effusion and mass spectrometric techniques, the respective vaporization processes were studied. Values of the heats of formation of these dicarbides are derived and compared with previous measurements on CaC_2. (auth)

811 (AERE-R-5012) A STUDY OF THE VAPOURISATION OF EUROPIUM DICARBIDE. Flowers, R. H. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 10p. Dep.; BIS $0.30; HMSO 1s. 9d.

A pure specimen of EuC_2 was synthesized from the elements and its vaporization behavior studied by means of precise Knudsen effusion measurements. The existence of a stable $EuC_{2.00}$ phase is confirmed and the equilibrium vapor, in the temperature range studied, is found to consist only of europium, presumably in monatomic form. The europium pressure follows the relation $4.757 \log_{10} P\ (atm) = -67390/T + 27.4$, from which the standard heat of formation of EuC_2 is estimated as $\Delta H^{\circ}_{298}(f) = -30.6$ kcal/mole ± 4.5. As with other incongruent vaporization processes, the attainment of the equilibrium pressure is significantly affected by solid-phase diffusion rates. (auth)

812 (BM-RI-6673) DETERMINATION OF A PART OF THE MAGNESIUM–ZIRCONIUM LIQUIDUS. Crosby, Robert L.; Fowler, K. A. (Bureau of Mines, Washington, D. C.). 1965. 19p. Bureau of Mines Free.

A part of the liquidus of the magnesium–zirconium system was determined by chemical analysis of suction samples taken from the melt in the approximate temperature range of 850 to 1,450°C. The melt was prepared in a furnace pressurized with an inert gas. The average zirconium value in weight-percent of the liquidus composition at each sampling temperature was 0.96 at 867°C, 1.40 at 1,062°C, 2.05 at 1,262°C, and 2.96 at 1,402°C. The equilibrium solid phase was zirconium. (auth)

813 (BNL–9479) SUPERCONDUCTIVITY IN TUNGSTEN FILMS AT TEMPERATURES NEAR 4 deg K. Kammerer, O. F.; Strongin, Myron (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 17p. (CONF-650936–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 1st International Symposium on Basic Problems in Thin Film Physics, Clausthal-Gottingen, Ger.

The transition temperature of sputtered or evaporated films was found to depend on the apparent particle size, which was determined by x-ray line broadening measurements. At a particle size of 250 Å, T_c was detected at 0.9°K. T_c increased as the particle size decreased, however, T_c decreased at a particle size of ~20Å. Annealing at 600 and 1200°C reduced T_c. The films exhibited a large critical field; a film with a particle size of 100 Å and T_c of 3.5°K had a critical field of 34,000 Oe at 1°K when the field was perpendicular to the plane of the film. This high value was attributed to the film being composed of many essentially isolated regions whose size was approximated by the x-ray line broadening measurements. High resistivity values were ascribed to oxide layers between the W particles. (W.L.G.)

814 (BNWL–142) A STUDY OF TUNGSTEN–TECHNETIUM ALLOYS. Quarterly Progress Report, April 1, 1965–July 1, 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1965. Contract AT(45-1)-1830. 18p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The microstructure of a series of arc-melted W–Tc alloys were studied. The observed coring, porosity, and appearance of two phases are discussed. Microhardness data were obtained and are plotted versus Tc concentration. Identification of the phases present and their lattice parameters were made by x-ray diffraction. (D.L.C.)

815 (BNWL-SA-209) COMPOSITIONAL AND PRESSURE EFFECTS IN THE PLUTONIUM–GALLIUM SYSTEM. Gardner, H. R. (Battelle-Northwest, Richland,

Wash. Pacific Northwest Lab.). June 4, 1965. Contract AT(45-1)-1830. 26p. (CONF-651102-4). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Royal Commonwealth Society, 3rd International Conference on Plutonium, London.

Lattice parameters, density, and hardness were determined on Pu–Ga alloys containing 0.37 to 1.26 wt % gallium. Lattice parameter and density decrease with increasing gallium content while hardness increases because of solid solution strengthening. The data are compared with the data of other investigators. The effect of a 150,000 psi pressure on alpha phase formation in both cored and homogenized alloy is presented. In addition, the stability of alpha-delta phase mixtures with respect to annealing and room temperature storage is discussed. An explanation of the observed behavior of alpha-delta phase mixtures is presented. (auth)

816 (BNWL-SA-210) FATIGUE BEHAVIOR OF PLUTONIUM–1.0 wt. % GALLIUM. DELTA STABILIZED PLUTONIUM. Gardner, H. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 4, 1965. Contract AT(45-1)-1830. 12p. (CONF-651102-5). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Royal Commonwealth Society, 3rd International Conference on Plutonium, London.

Several metallurgical conditions of both as-cast and rolled sheet were fatigue tested at room temperature in flexure with a superimposed mean stress of 5,400 to 6,700 psi. The frequency of stress reversal was approximately 215 cycles per second. The 0.1% yield strengths in the conditions tested ranged from 10,300 to 30,400 psi. Corresponding fatigue limits ranged from 10,000 to 15,000 psi for test durations of 10^7 to 10^8 cycles. The cored, as-cast condition and the homogenized, 94% cold rolled, 300°C annealed condition had the lowest fatigue limits, while the cored, 86% cold rolled sheet had the highest fatigue limit. The superimposed mean stress did not have a great effect on fatigue limit. (auth)

817 (CONF-710) HIGH-STRENGTH MATERIALS. Proceedings of the Second Berkeley International Materials Conference, held at the University of California, Berkeley, June 15–18, 1964. Zackay, Victor F. (ed.) (California Univ., Berkeley). Mar. 1965. Contract W-7405-eng-48. 879p. John Wiley and Sons, Inc., New York $22.00.

Twenty-two papers are included; separate abstracts have been prepared for eight. Five papers were previously abstracted for NSA; See 18: 37684, 44156, 44157, 44158, and 19: 2731. Papers not abstracted discuss strengthening mechanisms in high-strength materials, structure and properties of quenched iron alloys, strengthening mechanisms in ferritic and austenitic steels, lattice effects and the strength of alloys, deformation and transformation structures in shock-loaded iron-base alloys, strengthening glass and glass-ceramics by built-in surface compression, organic polymers and composites, and the acceleration of history. (W.L.G.)

For abstracts of individual papers see: 760, 779, and 882–887.

818 (EURAEC-1348) STUDY OF BASE METAL TO BE USED IN RESEARCH ON BRITTLE FRACTURE OF LARGE WELDED ASSEMBLIES. Technical Report No. 4, January 1, 1965–March 31, 1965. (Institut de Recherches de la Siderugrie, St. Germaine-en-Laye (France)). Apr. 1965. Contract 031-64-5 TEEF (RD). 28p. (EUR-2323). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Work Performed Under United States–Euratom Joint Research and Development Program.

Results are given of the hot and cold tensile tests which were conducted on Super Elso steel; they show a difference between the skin and the heart of the product. Transformation curves are given which were determined under isothermal conditions for the skin and heat, and under continuous cooling for the skin. Some results are also given of anisothermal stress relaxation tests. (D.L.C.)

819 (GA-6413) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report, February 1, 1965–April 30, 1965. Chambers, R. H.; Trozera, T. A. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). June 18, 1965. Contract AT (04-3)-167. 30p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Work was done on the development of annealing methods up to 1150°C. The results of an isochronal anneal of a rolled W single crystal are given. The preparation of pure single crystals of Mo is reported. A W single crystal was rolled into a sheet and annealed up to 2600°C, and tensile tests, surface examination, and x-ray photographs were made. Dislocation motion below 0.2 T_m was investigated in the bcc transition metals Ta and W. The results show that there is a critical concentration of interstitial impurities in well-annealed crystals, below which only intrinsic barriers control dislocation motion. (D.L.C.)

820 (GE-TM-64-10-4) THERMAL CONDUCTIVITY OF SEVERAL CERAMIC MATERIALS TO 2500 deg C. Feith, Allen D. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1964]. Contract AT(40-1)-2847. 17p. (CONF-764-11). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Thermal Conductivity Conference, San Francisco, Oct. 1964.

The thermal conductivity of several ceramic materials was measured by a radial heat flow technique to temperatures in excess of 2200°C with two materials being studied to 2500°C. Measurements performed on pure yttria, on pure UO_2, on a solid solution of these materials, and on stabilized zirconia of different compositions revealed some interesting effects of composition on the thermal conductivity of these materials. (auth)

821 (GE-TM-65-10-1) MEASUREMENTS OF THE THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF MOLYBDENUM. Feith, A. D. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1965]. Contract AT(40-1)-2847. 25p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The thermal conductivity of arc-cast molybdenum was measured in a radial heat flow device using refractory metal thermocouples for temperature determinations. Results of these measurements indicate that the conductivity of recrystallized molybdenum decreases linearly with temperature from 0.871 watt/cm-°C at 915°C to 0.727 watt/cm-°C at 1900°C. The construction and use of the thermocouples is discussed in detail. Electrical resistivity measurements were obtained on a tubular specimen which was fabricated from the same raw material as the thermal conductivity specimen. These results agree favorably with published values. The Lorenz function derived from these property measurements was found to decrease linearly with temperature. (auth)

822 (LA-DC-7278) STUDIES ON THE EQUILIBRIUM TEMPERATURE FOR THE PLUTONIUM ALPHA-BETA TRANSFORMATION. Anderson, J. W.; Gilmore, R. R.; Maraman, W. J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 27p. (CONF-651102-6). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Royal Commonwealth Society, 3rd International Conference on Plutonium, London.

The equilibrium temperature for the alpha-to-beta phase transformation of plutonium was determined to be 117.0 ± 0.5°C by measurement of the electric resistivity of thin, high-purity specimens. (auth)

823 (LA-DC-7456) HIGH TEMPERATURE THERMAL DIFFUSIVITY MEASUREMENTS BY THE FLASH TECHNIQUE. Morrison, B. H.; Klein, D. J.; Cowder, L. R. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 34p. (CONF-651020-1). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From 5th Thermal Conductivity Conference, Denver.

The pulse technique was applied to the measurement of the thermal diffusivity of tantalum and three grades of graphite over the 800 to 2200°C temperature range. A ruby laser system was used as the pulsed energy source; a

photomultiplier tube detected the transient time-temperature response of the back face of a thin sample. Corrections for the heat loss and finite pulse-time are included in the calculations for thermal diffusivity. The data for tantalum are in good agreement with literature values. The laser pulse technique was found to be a convenient, rapid, and precise method for routinely measuring the thermal diffusivity of small samples of solid materials. The extension of the technique to 3000°C and the simultaneous measurements of specific heat are discussed. (auth)

824 (NASA-CR-54458) DETERMINATION OF ELEVATED-TEMPERATURE FATIGUE DATA ON REFRACTORY ALLOYS IN ULTRA-HIGH VACUUM. Quarterly Report No. 4, April 1–July 1, 1965. Honeycutt, C. R.; Sawyer, J. C. (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). July 9, 1965. Contract NAS 3-6010. 25p.

A research program is being conducted to obtain fatigue life data on refractory alloys for use in designing space electric-power systems. The technique of displacement measurements using a cathetometer is described. Tests conducted on 0.25-in. dia TZM specimens stressed to 25,000 psi did not produce failures at ambient temperatures 72 and 1000°F after $\sim 2 \times 10^7$ cycles. However, a notch with a stress concentration factor of 3 resulted in very rapid failure at 1840°F in tension-compression loading with a calculated maximum stress of 16,800 psi on the unnotched cross-sectional area. (D.L.C.)

825 (NLCO-965, pp 2.1-3) THE URANIUM–CARBON PHASE DIAGRAM: THE MELTING POINTS OF URANIUM WITH VARIOUS CARBON LEVELS. Oblinger, C. J. (National Lead Co. of Ohio, Cincinnati).

High-purity uranium was heated to the liquid state in beryllium oxide or uranium oxide liners inside tungsten Knudsen cells. A uranium melting point of 1133°C was determined by optical pyrometry. Commercially pure uranium samples containing 187, 615, and 857 ppM carbon showed a melting point of approximately 1137°C. Metallographic examinations indicated a peritectic point at approximately 55 ppM carbon content. (auth)

826 (NP-15535) A BRIEF STUDY OF NICKEL-RICH ALLOYS OF THE Ni–Hf–C AND Ni–Zr–C SYSTEMS. Briggs, D. C. (Department of Mines and Technical Surveys (Canada). Mines Branch). Nov. 1964. 12p. (R-142). Bureau of Mines and Technical Surveys, Ottawa $0.50.

A brief study was made of the incidence, form, and stability of carbides of hafnium and zirconium in a nickel-base system. Alloys were studied in the Ni–Hf–C system up to 1 at. % C and 1 at. % Hf and in the Ni–Zr–C system up to 1 at. % C and 1 at. % Zr. In each system, a second phase was found which was extracted electrolytically and identified by x-ray diffraction techniques as a monocarbide of the reactive metal. Both HfC and ZrC were found to lack stability with changes in temperature; both ternary systems exhibited mild ageing response. (auth)

827 (ORNL-P-1670) A PULSE HEATING CALORIMETRIC TECHNIQUE FOR MEASURING THE SPECIFIC HEAT OF ELECTRICAL CONDUCTORS AND ITS APPLICATION TO PURE IRON FROM 100 TO 1400 deg C. Kollie, T. G. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 51p. (CONF-651020-4). Dep. mn; CFSTI $3.00 cy, $0.50 mn.

From 5th Thermal Conductivity Conference, Denver.

A pulse heating calorimetric technique for measuring the specific heat of electrical conductors over a wide temperature range is described. A direct current is used for Joule heating of an instrumented, rod-type specimen suspended in a constant-temperature, blackbody vacuum chamber. To determine the specific heat, the current flowing through the specimen is pulsed and a digital voltmeter, capable of recording 300 readings per second, measures the time dependence of the temperature change and the power dissipation in a known length of the specimen during the pulse. Radiation losses occurring during the nominally 4-sec pulse are accounted for by using total hemispherical emittance values obtained with the specimen at constant temperature. Errors in thermocouple measurements of surface temperature of a self-heated rod suspended in a blackbody at room temperature were considered on the basis of resistance thermometry for pure iron. An overall error analysis of the technique predicts an accuracy in the specific heat results of ±1.0% from 100 to 800°C. The accuracy and reproducibility of the technique were demonstrated by measurements on pure iron from 100 to 1400°C and by comparison with literature values. Below 910°C the reproducibility was assessed as ±0.5% and the agreement with other investigators was ±2.2%, except in the vicinity of the Curie transformation. The specific heat values from 910 to 1400°C are within 5% of several literature sources. At 772.8°C the specific heat of iron was found to change discontinuously from a value of 0.3457 to 0.2672 cal/g/°C. Consequently, the Curie phenomenon was adjudged to be a second-order transformation caused by a change in the rate of decoupling of aligned atoms at the ferromagnetic to paramagnetic transition. (auth)

828 (SC-DC-65-1588) MECHANICAL PROPERTIES OF SOME $PbZrO_3$–$PbTiO_3$ FERROELECTRICS. Dungan, Robert H. (Sandia Corp., Albuquerque, N. Mex.). Oct. 7, 1965. Contract AT(29-1)-789. 29p. (CONF-651018-1). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Joint Electronics Fall and 8th Pacific Coast Regional Meeting, Los Angeles.

The tensile strengths of several ferroelectric ceramics were measured using "dogbone," diametral, and hoop specimens. The hoop tensile test was judged the most satisfactory and was used in subsequent experiments to ascertain the effects of electroding, poling, and the application of static electric fields on the tensile strength of niobia-doped $PbZr_{0.52}Ti_{0.48}O_3$. The tensile strengths of the compositions investigated ranged between 6000 and 8000 psi for the ground, electroded material. The tensile strength of the doped $PbZr_{0.52}Ti_{0.48}O_3$ composition was observed to decrease by about 5 percent when electroded and by another 20 percent after repeated poling, i.e., DC looping. (auth)

829 (TID-22275) THE ELECTRICAL RESISTANCE OF CERIUM AS DETERMINED BY TEMPERATURE AND CRYSTAL STRUCTURE. Major, R. W.; Leinhardt, T. E. (Virginia Polytechnic Inst., Blacksburg. Dept. of Physics). Aug. 31, 1965. Contract AT(40-1)-2689. 30p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The results of studies of the relation between changes in the d-c resistance of several samples of pure cerium with changes in crystal structure are presented. In order to explain the erratic behavior of the metal, a search was made for evidence of isothermal transformations. Such evidence was found. An analysis of the isothermal data indicates that in the neighborhood of 80°K transformations to the alpha phase are determined by an activation energy process. (auth)

830 (UCRL-14215) INFLUENCE OF IRON ON OXYGEN GRAIN-BOUNDARY DIFFUSION IN PERICLASE CRYSTALS [Thesis]. McKenzie, D. R. (Lawrence Radiation Lab., Univ. of California, Livermore). Sept. 1, 1965. Contract W-7405-eng-48. 25p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Grain-boundary self-diffusion of oxygen in magnesium oxide was studied between 1658 and 1743°C by combining proton activation of oxygen-18 with autoradiography. This technique was also used to study oxygen grain-boundary self-diffusion in iron-doped magnesium oxide between 1621°C and 1679°C. It was shown that ferric iron in concentrations of 350 atomic ppm or higher increased oxygen grain-boundary self-diffusion in magnesium oxide at 1650°C by one order of magnitude. Activation energies were not calculated because of the short temperature ranges which were covered by the anneals. (auth)

831 (UCRL-14274) VAPORIZATION OF ADVANCED POWERPLANT METALS UNDER VACUUM

AND FORCED CONVECTION CONDITIONS. Zima, G. E. (Lawrence Radiation Lab., Univ. of California, Livermore). June 24, 1965. Contract W-7405-eng-48. 25p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Calculations were made for several potential structural metals to determine mass loss, surface recession, and change in cross-sectional area resulting from protracted vaporization (10,000 hr) under vacuum and under forced convection. An arbitrary forced convection situation was assumed: helium under 1 atm total pressure and with free-stream velocity of 100 ft/sec. Results indicate that vaporization will not be a problem for tungsten, rhenium, and tantalum below temperatures of about 4000°F. For molybdenum, vaporization may become troublesome at about 2900°F in vacuum and 3300°F under forced convection. To allow for forced convection conditions different from those assumed in the above-mentioned calculations, corrections are given for total pressure, temperature, free-stream velocity, and distance from the leading edge of the metal shape along which the gas is flowing. Also given are factors for converting from convection with helium to convection with argon or hydrogen. For given forced convection conditions, it appears that argon produces ~50% less mass loss than helium, and hydrogen ~5% more. (auth)

832 (UCRL-16180) I. SOME MEASUREMENTS OF MAGNETIC HYPERFINE HEAT CAPACITIES. II. HEAT CAPACITIES OF COPPER-MANGANESE ALLOYS BELOW 1 deg K [Thesis]. Ho, James Chien-Ming (Lawrence Radiation Lab., Univ. of California, Berkeley). Sept. 1965. Contract W-7405-eng-48. 92p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

I. The hyperfine fields at Mn nuclei in antiferromagnetic γ-manganese and gold-manganese were calorimetrically determined to be 65 and 320 kOe, respectively. For antiferromagnetic chromium, however, the magnetic hyperfine heat capacity was not observed at temperatures as low as 0.06°K, and only an upper limit to the hyperfine field at Cr nuclei, 13 kOe, could be obtained. All these values are smaller than that expected from the results for the ferromagnets of the iron series, iron, cobalt, and nickel. This apparent difference might be due to the 4s-electron contribution or to the exchange polarization of the 3s-electrons of one ion by the 3d-electrons of its neighbors. The magnetic hyperfine heat capacities of two alloys containing respectively 0.75 at.% Os and 3.21 at.% Pt dissolved in Fe were also measured. The hyperfine fields at the nuclei were found to be 1400 kOe for Os and 1390 kOe for Pt. II. Measurements of the heat capacities of dilute manganese in copper alloys were made below 1°K to determine the contribution to the low-temperature heat capacity that is associated with the magnetic ordering process. The theoretical low-temperature limit for this anomaly, which is linear in temperature and independent of manganese concentration, was not observed, although the heat capacity was found to be remarkably insensitive to manganese concentration. The heat capacities of several higher manganese content copper-manganese alloys were also determined. For all samples used in this work, which cover the whole composition range of the copper-manganese system, the hyperfine fields H_e at Mn nuclei were calculated from the observed hyperfine heat capacities by neglecting the contributions from Cu nuclei. These values and that of γ-manganese give a more or less linear relation between manganese content and H_e, which changes from 65 kOe for γ-manganese to about 305 kOe for the dilute manganese alloys. (auth)

833 (WERL-8844-5) IRRADIATION EMBRITTLEMENT OF PRESSURE VESSEL STEELS. PART II. TRANSFORMATIONS AND MICROSTRUCTURE. Eichelberger, T. W.; Wessel, E. T. (Westinghouse Research Lab., Pittsburgh, Pa.). Jan. 15, 1965. Contract AT-11-1-GEN-14. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The continuous cooling transformation diagram was determined from data representing seven heats of ASTM, A302B steel. Microstructures produced by various cooling rates in the different lots of steel were examined in detail. There was no obvious difference in transformation behavior or microstructure between irradiation sensitive and insensitive heats of steel. Inhomogeneities and heat to heat variations were observed, and these factors could be responsible for obscuring any basic differences that might have prevailed between sensitive and insensitive materials. (auth)

834 (AERE-Trans-1031) DIFFUSION AND THERMODYNAMIC CHARACTERISTICS OF NICKEL-CHROMIUM ALLOYS. Fedorov, G. B.; Smirnov, E. A.; Zhomov, F. I. Translated by J. J. Cornish (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot, No. 4, 110-21(1963). 12p. BIS $0.50; HMSO 2s. 6d.

The diffusion of Ni and Cr in Ni-Cr alloys containing up to 20 at. % Cr was studied at 950 to 1250°C, using ^{63}Ni and ^{51}Cr radioisotopes. The effects of alloying with Cr on the diffusion coefficients and activation energies are discussed. The thermodynamic properties of Ni-Cr alloys containing 7 to 36 at. % Cr were determined by measuring the partial vapor pressures of ^{63}Ni and ^{51}Cr above the alloys, using Knudsen's method. The anomalously high vapor pressures of Ni above the alloys are explained on the basis of the kinetic conditions of vaporization. The vapor pressure of pure Cr was measured and found to agree with previous data. The partial vapor pressures and thermodynamic properties of Cr in Ni-Cr alloys were determined at 1387°C. Interdiffusion coefficients and their activation energies (according to Darken) were computed for Ni-Cr alloys at 750, 1100, and 1387°C. (D.L.C.)

835 (AERE-Trans-1035) IDENTIFICATION OF KINK BANDS IN PLASTICALLY DEFORMED LAMELLAR PEARLITE. Proeger, M. Translated by J. B. Sykes (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Prakt. Metallog., 1: No. 4, 138-40(1964). 3p. BIS $0.30; HMSO 1s. 9d.

By the plastic deformation of ferritic steels, the lamellar pearlite deforms partially by forming kink bands. They can be demonstrated spatially on the surface of etched compression test specimens after an additional deformation. The difference in orientation of the ferrite between band and matrix can be shown by a sodium picrate etching. (auth)

836 (UCRL-Trans-1213(L)) DYNAMIC ADIABATIC CURVE FOR URANIUM. Viard, J. Translated by W. G. Robinson (Univ. of California Lawrence Radiation Lab., Livermore) from Colloq. Intern. Centre Nat. Rech. Sci. (Paris), (1961). 13p. Dep. mn; JCL $1.60 fs, $0.80 mf.

The dynamic adiabatic curve for shock wave compression of uranium was determined from 270 to 620 kb. A discontinuity of slope appears at about 505 kb, similar to that in iron at 130 kb. The measurements were made by the argon chamber technique. (auth)

837 THREE-STAGE HARDENING IN TANTALUM SINGLE CRYSTALS. Mitchell, T. E.; Spitzig, W. A. (Case Inst. of Tech., Cleveland). Acta Met., 13: 1169-79 (Nov. 1965).

Three-stage hardening was found to occur in tantalum single crystals deformed in tension over a limited range of orientations, temperatures, and strain-rates. The orientation range is for crystals oriented favorably for single glide. The temperature range corresponds to $T/T_m \simeq 0.10$ to 0.18. Above this temperature range stages I and II tend to disappear; below this temperature range the initial flow stress starts to increase rapidly and there is also an abrupt decrease in the uniform elongation. Increasing the strain-rate was found to be entirely analogous to decreasing the temperature. The slip direction is ⟨111⟩ and the slip planes approximate to those carrying the highest resolved shear stress, except at 4.2°K where {110} slip planes were observed. Twinning was also observed at 4.2°K: the twin system, which is of the type ⟨111⟩{112}, was found to be the expected one for tensile deformation. Fracture occurred by cleavage at these low temperatures and by chisel edge necking at higher temperatures. The work-hardening rate in stage II is ~G/600. (auth)

838 THE EFFECT OF HIGH VACUUM PURIFICATION ON THE MECHANICAL PROPERTIES OF NIOBIUM SINGLE CRYSTALS. Taylor, G.; Christian, J. W. (Univ. of Oxford). Acta Met., 13: 1216-18(Nov. 1965).

Experiments on the removal of interstitial impurities from Nb by heating in high vacuo to >2400°C, and the effects of this treatment on the mechanical properties are described. The actual impurities achieved are not known, but it was clear from the measured physical and mechanical properties that considerable improvements were attained. The resistivity ratio $\rho_{300}/\rho_{4.2}$ was ~200:1 and ~4,000:1 in an as-grown and a treated crystal, respectively. In the as-grown crystals, the resolved shear stress at the yield point was ~4,000 g mm^{-2} at room temperature, whereas crystals annealed in ~1×10^{-8} torr had a resolved shear stress of 850-900 g mm^{-2}. All mechanical tests were made in compression at a strain rate of 6×10^{-4} sec^{-1}. Two crystals annealed in a vacuum of 5×10^{-8} torr gave yield stresses of 950 and 1,300 g mm^{-2} when the final temperature was the melting point and 2240°C, respectively. (P.C.H.)

839 PHASE EQUILIBRIA IN UO_2–Sc_2O_3 AND ThO_2–Sc_2O_3 SYSTEMS. Trzebiatowski, W.; Horyn, R. (Technical Univ., Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 13: 303-9(1965).

X-ray analysis and melting points data on the phase equilibria in $UO_2-Sc_2O_3$ and $ThO_2-Sc_2O_3$ systems are presented. Both diagrams represent simple eutectic systems without noticeable solubility of the components. Composition of the eutectics are: for $UO_2-Sc_2O_3$, 82 mole % $ScO_{1.5}$ at 2280°C and for $ThO_2-Sc_2O_3$, 83 mole % $ScO_{1.5}$ at 2220°C. (F.J.H.)

840 PHASE EQUILIBRIA IN THE Y_2O_3–Sc_2O_3 SYSTEM. Trzebiatowski, W.; Horyn, R. (Technical Univ., Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 13: 311-14(1965).

Data on the phase equilibria in the $Y_2O_3-Sc_2O_3$ system are presented. Melting points were determined and powder diagrams taken. From the phase diagram a series of continuous solid solutions with a temperature minimum at 45 mole % Y_2O_3 and 2100°C is evident. These solutions represent the Mn_2O_3 type of structure. (F.J.H.)

841 PHASE EQUILIBRIA IN THE CaO–Sc_2O_3 SYSTEM. Trzebiatowski, W.; Horyn, R. (Technical Univ., Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 13: 315-17(1965).

The phase equilibria in $CaO-Sc_2O_3$ systems were determined by x-ray analysis of samples sintered at various temperatures and by their melting points. Data on melting points, sintering temperatures, and x-ray analysis are given. The existence of a $CaSc_2O_4$ compound melting at 2110°C was ascertained. It divides the system into two partial eutectic systems, and the eutectic points are 57.0 mole % $ScO_{1.5}$ at 1960°C and 73.5 mole % $ScO_{1.5}$ at 2015°C. (F.J.H.)

842 THE MAINTENANCE OF THE PROPERTIES OF SAP AFTER A TREATMENT OF FUSION OF THE MATRIX. Piatti, G.; Beghi, G. (CCR-EURATOM, Ispra, Italy). Energia Nucl. (Milan), 12: 526-37(Oct. 1965).

In the framework of the ORGEL Project, a study was carried out concerning the stability at fusion of dispersed phase alloys Al–Al_2O_3 (SAP). Thermal treatments above the melting point of Al in specific conditions of temperature and time, followed by an extrusion procedure, did not cause any major variations in the structure of SAP itself. Future practical applications of SAP are discussed. (auth)

843 DEFECT STRUCTURE AND ELECTRICAL CONDUCTIVITY OF ThO_2–Y_2O_3 SOLID SOLUTIONS. Subbarao, E. C.; Sutter, P. H.; Hrizo, J. (Westinghouse Research Labs., Pittsburgh). J. Amer. Ceram. Soc., 48: 443-6(Sept. 21, 1965).

Compositions in the system ThO_2–$YO_{1.5}$ were coprecipitated as oxalates and converted to oxides. Disks were pressed and sintered in oxygen at 1400 to 2200°C. Densities of the sintered disks were 96 to 98% of theoretical. Solid solutions with the fluorite-type structure were formed up to 20 to 25 mole % $YO_{1.5}$ at 1400°C and up to 45 to 50 mole % $YO_{1.5}$ at 2200°C. Density data showed that these solid solutions correspond to $Th_{1-x}Y_xO_{2-0.5x}$, having a complete cation sublattice filled by Th^{4+} and Y^{3+} ions, and vacancies in the anion sublattice. The observed increase in electrical conductivity with increase in $YO_{1.5}$ content is consistent with charge transport by oxygen ions through a vacancy mechanism. Approximately 7 mole % ThO_2 is soluble in $YO_{1.5}$ at 2200°C. Density results indicate an anion interstitial structure for the Y_2O_3 phase. Transference number measurements indicate that the electrical conductivities are only partly due to ions. (auth)

844 PEROVSKITE-TYPE RARE-EARTH NIOBATES AND TANTALATES. Rooksby, H. P.; White, E. A. D.; Langston, S. A. (General Electric Co. Ltd., Wembley, Eng.). J. Amer. Ceram. Soc., 48: 447-9(Sept. 21, 1965).

A family of perovskite-type compounds of composition $A_{0.33}BO_3$ was prepared by high-temperature heat treatment of appropriate mixtures of trivalent rare-earth oxide ($A_2^{3+}O_3$) niobia or tantala ($B_2^{5+}O_5$). The A-type cations investigated included La, Ce, Pr, Nd, Sm, Gd, Dy, Y, and Yb. The compounds which can be formed with niobia appear to be limited to those containing A-type cations of radius greater than that of samarium, but with tantala the range extends down to ytterbium. The perovskitelike crystal structures are tetragonal or pseudotetragonal with an axial ratio ~2. For the majority, the two-cell pseudotetragonal unit shows either orthorhombic or monoclinic distortions, the lower monoclinic symmetry characterizing those containing the smallest rare-earth cations, dysprosium, yttrium, and ytterbium. Niobia and tantala compounds of similar structure and composition were formed from ceria and praseodymia and the rare-earth cations appeared to be substantially reduced to the trivalent state during the high-temperature reactions. (auth)

845 ELECTRICAL PROPERTIES AND DEFECT STRUCTURE OF ZIRCONIA: II. TETRAGONAL PHASE AND INVERSION. Vest, R. W.; Tallan, N. M. (Systems Research Labs., Inc., Dayton, Ohio; Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Amer. Ceram. Soc., 48: 472-5(Sept. 21, 1965).

The defect structure of tetragonal zirconia was investigated by measuring the temperature and oxygen partial pressure dependence of the electric conductivity and the electronic transference number. Tetragonal zirconia was a mixed electronic and ionic conductor under all conditions studied. The n-type electronic conductivity observed at high temperatures and low oxygen partial pressures was interpreted on the basis of a defect model involving fully ionized oxygen vacancies. The conductivity change associated with the monoclinic ⇌ tetragonal phase transformation was isothermal, but the rate of change was a function of the thermal history and the method of preparation of the sample. (auth)

846 SOLUTE-INDUCED GRAIN BOUNDARY HARDENING AND THE SINTERING OF BeO. Sjodahl, L. H.; Westbrook, J. H. (General Electric Co., Schenectady, N. Y.). J. Amer. Ceram. Soc., 48: 478-80(Sept. 21, 1965).

Grain boundary hardness studies on sintered BeO with and without additives such as CaO, ZrO_2, and MgO imply a segregation of these additives to the grain boundary region similar to the segregation of MgO in Al_2O_3 demonstrated by others. (auth)

847 THE SYSTEM WO_3–B_2O_3. Levin, Ernest M. J. Amer. Ceram. Soc., 48: 491-2(Sept. 21, 1965).

Phase equilibrium relations in the system $WO_3-B_2O_3$ were determined as part of a comprehensive study of liquid immiscibility in borate systems. Quenched samples were examined with the binocular and polarizing microscopes and by x-ray powder diffractometry using a high-angle Geiger counter diffractometer. The phase diagram for the system shows no compounds, solid solutions, or immiscibility. The system is of a simple eutectic type with an S-shaped liquidus and with a solidus that must lie near 450°C

(the approximate melting point of crystalline B_2O_3). The melting point of WO_3 was established at 1435°C. It was concluded that liquid immiscibility does not exist if the modifier cation–oxygen bond is either too weak, as in the alkali borates and silicates, or too strong, as in the system WO_3–B_2O_3. (P.C.H.)

848 PHASE EQUILIBRIA IN THE SYSTEM ALUMINUM OXIDE-TUNGSTEN OXIDE. Waring, J. L. J. Amer. Ceram. Soc., 48: 493-4(Sept. 21, 1965).

The system Al_2O_3–WO_3 was investigated as part of a fundamental study of phase equilibria of refractory oxides. One compound was found in the system, melting congruently at 1254°C, with the approximate composition of $2Al_2O_3$: $5WO_3$. Because of the high refractive index and apparent low symmetry of $2Al_2O_3$: $5WO_3$, microscopic characterization was not applicable. The proposed phase equilibria are illustrated. (P.C.H.)

849 ADSORPTION AND SURFACE DIFFUSION OF COPPER ON TUNGSTEN. Melmed, Allan J. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). J. Chem. Phys., 43: 3057-62(Nov. 1, 1965).

The Cu/W adsorption system was studied by field-emission microscopy. Adsorption of one to ten atomic layers of Cu was followed through changes in the field-electron-emission pattern and average work function of the W field emitter. Surface diffusion was investigated for single-, double-, and triple-layer diffusion, and for successive diffusion of one layer of Cu on others up to four layers. The negative electric field used in some of the measurements was found to decrease the apparent activation energy and the pre-exponential factor of the diffusion equation. The activation energy varied over the tungsten surface, increasing with surface roughness; it also varied with coverage, decreasing rapidly at first and then slowly with increasing coverage. It is suggested that the limiting values of Q and D_0 approximate the values for surface self-diffusion of Cu. (auth)

850 THE CRYSTALLOGRAPHY OF DEFORMATION TWINNING IN ALPHA-URANIUM. Crocker, A. G. (Battersea Coll. of Tech., London). J. Nucl. Mater., 16: 306-26(July 1965).

A detailed analysis is given of the crystallography of deformation twinning in α–uranium and in particular of the prediction of operative twinning elements. The classical laws of the crystallography of deformation twinning are first summarized and a brief description given of some of the possible atomic shuffle mechanisms which in general must accompany the twinning shear. Available results on the observed twinning modes of α–uranium are then described, together with a review of previous attempts to explain their appearance in terms of the crystallographic theories. This is followed by a new analysis of the problem, in which it is shown that there are 41 twinning modes with reasonably simple shuffle mechanisms and shears less than unity. The different types of mode which arise are discussed and the shuffles associated with the 5 modes with the smallest shears examined in detail. Apart from one rarely observed mode, which is discussed separately, these include all the modes reported in practice. It is shown that a detailed examination of the twinning shears, shuffle mechanisms, and shuffle magnitudes and directions enables an adequate understanding of the observed twinning planes in α–uranium to be obtained. Finally the relevance of these results to deformation twinning in other materials is discussed. (auth)

851 INITIAL SUSCEPTIBILITY INVESTIGATION OF MAGNETIC TRANSITIONS IN SEVERAL RARE EARTH METALS: THERMAL HYSTERESIS IN FERROMAGNETIC TRANSITIONS. Jelinek, F. J.; Hill, E. D.; Gerstein, B. C. (Iowa State Univ., Ames). J. Phys. Chem. Solids, 26: 1475-88(Sept. 1965). (IS-1100).

Thermal hysteresis of magnetic transitions in polycrystalline Gd, Tb, Dy, Ho, Tm, and Sm were investigated by a mutual inductance magnetic susceptibility technique. A thermal hysteresis effect was observed in the ferromagnetic transitions of Tb, Dy, Ho, and Tm. No thermal hysteresis was observed in the magnetic transitions of Gd and Sm. The magnetic transition temperatures obtained in all of the metals investigated are discussed and compared with other works. (auth)

852 GRAPHITE FOR FUEL ELEMENTS. Vohler, O. (Siemens-Planiawerke AG fuer Kohlefabrikate, Meitingen, Ger.). Kerntechnik, 7: 367-72(Aug.-Sept. 1965). (In German).

The properties of artificial graphites can be varied very widely by selection of appropriate raw materials and methods of production. In this way not only strength, conductivity, and irradiation behavior but permeability, porosity, and corrosion resistance can be adapted to the requirements of the reactors under consideration. (auth)

853 PROPHYLACTIC ANALYSIS OF FUEL ELEMENT DAMAGE IN BOILING WATER REACTORS. Faber, P. (Versuchsatomkraftwerk Kahl GmbH, Ger.). Kerntechnik, 7: 375-8(Aug.-Sept. 1965). (In German).

By evaluation of the gamma spectra of some characteristic gaseous and water-soluble iodine isotopes the true activity rate at the fuel-element surface was calculated. Characteristic quantities can be shown to be a measure for the condition of the fuel elements against fission-product penetration. In case of pure diffusion the actual activities depend on half life and fission yield; in case of macroscopic rupture fission yield alone will determine the actual activities. (auth)

854 FISSION GAS RELEASE FROM URANIUM DIOXIDE. Holzer, R. (Siemens-Schuckertwerken AG, Erlangen, Ger.). Kerntechnik, 7: 378-83(Aug.-Sept. 1965). (In German).

Proceedings influencing the release of gaseous fission products from UO_2 are discussed. It is shown that reliable predictions on gas release are only possible if the theoretical calculations are connected with empiric understanding. The usual diffusion model is only an approximation and does not give a satisfactory explanation for the experimental results. (auth)

855 STUDY OF VANADIUM AS DIFFUSION BARRIER BETWEEN ALUMINIUM AND URANIUM. Huet, J.-J. (CEN, Mol, Belg.); Musso, G.; Brossa, F.; Theisen, R. Mem. Sci. Rev. Met., 62: 561-72(July-Aug. 1965). (In French).

Different temperatures of reaction were studied for solid vanadium with uranium and aluminum. The vanadium deposition, which formed the diffusion barrier, was obtained by vacuum vaporization. The compositions of different diffusion zones were determined. Ternary diffusion laws were established as a function of the temperature of the life of the nuclear element to calculate the thickness of the back-diffusing layer. (auth)

856 CONTRIBUTION TO THE STUDY OF PLASTIC DEFORMATION AND CONSOLIDATION OF POLYCRYSTALLINE BERYLLIUM IN THE RANGE FROM ROOM TEMPERATURE TO 500 deg C. Gasc, C. Mem. Sci. Rev. Met., 62: 579-90(July-Aug. 1965). (In French).

Twinning is a very important type of deformation between –25 and +200°C and can give deformation of the order of 8%. Above 300°C, folding plays a predominant part; at 400°C it determines a real substructure capable of producing a type of recrystallization. (auth)

857 SLOW-BEND TESTING OF HYDRIDED ZIRCONIUM. Coleman, C. E.; Hardie, D. (Univ. of Newcastle upon Tyne, Eng.). Nature, 208: 69-70(Oct. 2, 1965).

Using a standard Hounsfield slow-bend specimen in the usual slow-bend jig, but attaching the latter to a hard-beam testing machine, the effects of various variables on the hydrogen embrittlement of Zr was studied. The results indicate the importance of the yield drop and its dependence on temperature, hydrogen content, and interhydride spacing. The latter is an important factor which may vary consider-

ably with grain size and heat treatment even with a constant hydrogen. (P.C.H.)

858 ELECTRON BEAM ELECTRON MELTING OF REFRACTORY METALS. III. THE TENSILE PROPERTIES OF ELECTRON BEAM MELTED MOLYBDENUM WIRES. Takaai, Tetsuya; Ishii, Mitsuru (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 29: 441-6(1965). (In Japanese).

The tensile and recrystallization properties of electron-beam-melted molybdenum wires were studied and compared with those of arc-melted and sintered molybdenum. The recrystallization temperature range of electron-beam-melted molybdenum wires was 930 to 1090°C, while those of arc-melted and sintered were 820 to 1070°C and 740 to 1260°C, respectively. A linear relationship was observed between yield strength and 1/T for three kinds of molybdenum wires. The temperature range of the linear relationship was 140 to 70°C for electron-beam-melted molybdenum wires, 160 to 80°C for arc-melted molybdenum wires and 180 to below −110°C for sintered molybdenum wires. The parameters for the yield strength vs 1/T diagrams were 23.5×10^3, 27.0×10^3, and 30.0×10^3 kg/mm^{-2} T°K for the electron-beam-melted, arc-melted, and sintered molybdenum wires, respectively. The ductile-to-brittle transition temperatures in the tensile test (with strain rate of 2.1×10^{-3} s^{-1}) for recrystallized electron-beam-melted and arc-melted molybdenum wires were −70 and −80°C, but the transition temperatures varied very sensitively with changes in the annealing temperature. Sharp peaks were observed at about 200°C in strain hardening exponent vs the reverse of test temperature diagrams for 3 molybdenum wires, and the strain hardening exponents of electron-beam-melted molybdenum wires were the highest at all the test temperatures and those of arc-melted were the lowest. (auth)

859 AGING MECHANISM OF SINTERED WC–Co HARD METALS. Suzuki, Hisashi; Sugiyama, Masataka; Umeda, Takateru (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 29: 467-71(1965). (In Japanese).

The aging mechanism of cemented carbides, i.e., the mechanism of precipitation of tungsten atoms when low-carbon systems are annealed, was studied. The specimens used were two phase WC–Co systems vacuum-sintered at 1400°C for 1 hr and subsequently vacuum-annealed up to 30 hr at temperature below 950°C. Tungsten atoms supersaturated in the binder phase precipitated in the form of Co_3W according to the reaction γ (fcc) → γ (fcc) + Co_3W. The precipitate of Co_3W was formed on (001) cubic planes of the face-centered binder phase. The hardness increase of the binder phase was considered due to a precipitation hardening by Co_3W. The decrease in magnetic saturation was also attributed to the precipitation of Co_3W presumed to be nonmagnetic. The solid solubility of tungsten in the cobalt phase was determined. The strength of low-carbon systems seemed to be considerably improved by solution treatment. But, for the purpose of obtaining high strength systems, the preparation of high-carbon systems is far more desirable than the solution treatment of low-carbon systems. (auth)

860 THE DETECTION OF EMBRITTLEMENT IN STEELS BY MEANS OF HARDNESS MEASUREMENTS. Oku, T.; Sato, S.; Fujimura, T. (Japan Atomic Energy Research Inst., Ibaraki-ken). Nucl. Struct. Eng., 2: 282-92(1965).

A preliminary study was carried out regarding the relation between hardness and brittleness in steels. The temperature dependence of Vickers hardness on the steels was studied over a range from −196 to 100°C. It was found that the logarithmic hardness versus the reciprocal of absolute temperature can be described by several linear stages. If the intersection of the two lowest temperature stages is defined as a hardness ductile-brittle transition temperature, the increase in the transition temperature during irradiation was approximately consistent with data obtained with the Charpy impact test. By obtaining the temperature dependence of hardness embrittlement in steel can be detected easily. (auth)

861 KNIGHT SHIFTS AND MAGNETIC SUSCEPTIBILITIES IN RARE-EARTH-TIN INTERMETALLIC COMPOUNDS. Udaya Shankar Rao, V.; Vijayaraghavan, R. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 19: 168-9(Oct. 15, 1965).

The tin Knight shifts and magnetic susceptibilities in the intermetallic compounds RSn_3 (R = Ce, La, Nd, Pr, Sm, and U) were measured from 90 to 300°K in order to investigate the coupling between the rare-earth and conduction electron spins. (D.C.W.)

862 THE MOESSBAUER EFFECT IN SOME TIN RICH ALLOYS. Longworth, G.; Deeney, F. A.; Packwood, R. H. (Univ. of Birmingham, Eng.). Phys. Lett., 19: 188-9(Oct. 15, 1965).

Resonant absorption was studied in Sb-Cu-Sn, In-Sn, and Pb-Sn alloys at room temperature and near the melting point. Resonance line widths and recoilless fractions were measured. The results show that the anomalous decrease in resonant absorption, observed in impure absorbers near the melting point, is not due to enhanced self-diffusion. It seems likely that all the decrease in resonant absorption is due to the reduced solid fraction. (D.C.W.)

863 EFFECTS OF HIGH MAGNETIC FIELDS ON THE ULTRASONIC VELOCITY AND ATTENUATION IN Nb–25% Zr. Shapira, Y.; Nueringer, L. J. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 15: 724-7(Nov. 1, 1965).

The variations of the attenuation and velocity of longitudinal and shear waves propagating in normal and superconducting Nb–25% Zr were measured as a function of applied magnetic fields up to 100 kgauss. The results are in agreement with the predictions of the Alpher-Rubin theory. (D.C.W.)

864 EFFECTS OF DILUTE RARE-EARTH ADDITIONS ON THE ELECTRICAL CONDUCTIVITY OF CERIUM AT LOW TEMPERATURES. Clinard, F. W.; Elliott, R. O.; Miner, W. N. (Univ. of California, Los Alamos, N. Mex.). Phys. Status Solidi, 11: 595-602(Oct. 1965). (LA-DC-6982).

Two atomic percent of the various trivalent rare earths were dissolved in cerium, and the electric resistivities of these dilute binary alloys were evaluated in the range 1.5 to 297°K in order to determine whether the various solute properties might be reflected in resistivity measurements. The γ- and β-cerium phases at room temperature showed a roughly linear dependence of resistivity on atomic number of the rare-earth solute; noted was a slight effect attributed to solvent-solute atomic size mismatch. At 4°K the resistivities of predominantly α phases were found to be influenced by small amounts of β, and predominantly β phases by small amounts of α. Spin-disorder resistivities for the β phase of the various alloys did not reflect the influence of any solute magnetic parameters, but did decrease slightly in the direction of the heavier rare-earth solutes. (auth)

865 ON THE DISTRIBUTION OF ELEMENTS DURING FORMATION OF SINTERED ALLOYS IN THE W–Ni–Fe SYSTEM. Dzykovich, I. Ya.; Makarova, R. V.; Teodorovich, O. K.; Frantsevich, I. N. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 8, 62-9(Aug. 1965). (In Russian).

The distribution of elements in tungsten–nickel–iron alloys was studied. A roentgenospectral analysis of microvolumes showed that introduction of iron into the alloy affects the mutual solubility of tungsten and nickel. In alloys containing iron the heterodiffusion front was constricted as compared with the tungsten–nickel alloy. The distribution of iron in tungsten grains remained constant irrespective of the alloy composition, and was more uniform despite its solubility, which was five times as great as that of nickel in alloys with an identical ratio of elements in the bond. (auth)

866 ON THE PRODUCTION OF ETCH FIGURES ON ORIENTED SURFACES OF HIGH-MELTING METALS. Finke, Peter (Institut fuer Angewandte Physik der Reinststoffe, Dresden). Prakt. Metallog., 2: 151-61 (Aug. 1965). (In German).

The general principles of the etching of dislocations are treated and tables of etching solutions for the origination of etch figures on refractory metals are given. Experience obtained by the etching of oriented single crystal faces of W, Mo, Nb, Ta, and Re is reviewed. (auth)

867 FUSED ZIRCONIA REFRACTORIES. III. EFFECTS OF ADDITIVES ON THE STABILIZATION OF ZIRCONIA. Yonemochi, Osamu; Okubo, Tsutomu (and others) (Government Ind. Res. Inst., Nagoya, Japan). Rept. Govt. Ind. Res. Inst., Nagoya, 13: 453-60(Dec. 1964). (In Japanese).

The mixture of ZrO_2 (>99.5%) and a small amount of CaO as a stabilizer was heated to 800 to 1500°C after adding SiO_2, TiO_2, Al_2O_3, or Fe_2O_3 as an additive, respectively. A part of these mixtures was fused by an arc furnace. After the heat treatments, the samples were examined by x-ray analysis and thermal expansion test. All of the additives reacted with CaO at high temperatures to the related compounds. Al_2O_3, TiO_2, and SiO_2 considerably retarded the formation of cubic ZrO_2, while Fe_2O_3 had a tendency to accelerate it. When the samples containing SiO_2 were heated higher than 1200°C, the formation of cubic ZrO_2 was retarded and its amount was inversely proportional to the temperature. It was found that SiO_2 reacted with CaO in the ZrO_2–CaO solid solution, and cubic ZrO_2 transformed into monoclinic ZrO_2. Except for the sample containing SiO_2, all the samples fused by an arc furnace were stabilized well. The sample containing SiO_2 showed various differences in stabilization according to the fusing conditions. (NSA of Japan)

868 ELECTRIC PROPERTIES OF Pr_2Se_3 AND Nd_2Se_3. Lashkarov, G. V.; Paderno, Yu. B. (Kiev State Univ.). Ukr. Fiz. Zh., 10: 566-8(May 1965). (In Ukrainian).

The thermoelectric conductivity and resistivity of Pr_2Se_3 and Nd_2Se_3 were studied in the temperature range from 400 to 1200°K at a vacuum of about 10^{-4} mm of Hg. X-ray diffraction studies revealed that the lattice structures of these selenides are of the Th_3P_4 type, with constants of 8.89 Å and 8.85 Å, respectively for the Pr and Nd compounds. Their specific resistivity was about 5×10^8 and 2×10^7 ohm/cm, respectively. Pr_2Se_3 exhibited typical semiconducting properties, without any additional conductivity; the selenide Nd_2Se_3 behaved differently, changing from the mixed type to direct conductance at 600 to 700°K. The thermoelectromotive force of the mixed conductivity had a negative sign that changed into a positive one at 700°K and reached a maximum at 800°K. Transition from the corresponding sulfides to the selenides resulted in a reduction of the forbidden zone. The resulting reduced conductivity was caused by the higher energy distribution of the 4 p selenide zone with respect to the 3 p sulfide zone. Thus, both compounds are considered refractory semiconductors. (TTT)

869 PREPARATION AND CRYSTAL STRUCTURE OF THE SAMARIUM, EUROPIUM, AND YTTERBIUM OXIDE BROMIDES LnOBr AND Ln_3O_4Br. Baernighausen, H.; Brauer, G.; Schultz, N. (Univ., Freiburg i. B.). Z. Anorg. Allg. Chem., 338: 250-65(Aug. 1965). (In German).

Various methods for the preparation of SmOBr, EuOBr, YbOBr, Sm_3O_4Br, Eu_3O_4Br, and Yb_3O_4Br are described. According to x-ray diffraction powder photographs of the new compounds, the oxide bromides LnOBr belong to the PbFCl type like nearly all of the other known rare earth oxide halides, whereas the orthorhombic compounds Ln_3O_4Br have their own structure type which is not yet known. In a review of the rare earth oxide halides of the PbFCl type it is shown, that besides characteristic common structural features, remarkable crystal chemical differences appear depending on the size of the halide or rare earth ions, respectively. (auth)

870 PYROLYSIS PRODUCTS OF URANIUM TRIOXIDE MONOHYDRATES. II. STUDIES OF THE INFRARED SPECTRA. Imrisova, D.; Urbanec, Z. (Institut fuer Kernforschung, Akademie der Wissenschaften, Prague). Z. Anorg. Allg. Chem., 338: 312-18(Aug. 1965). (In German).

The reaction products of the thermal decomposition of $UO_3 \cdot 0.8\ H_2O$, being formed at rising temperatures from 220 to 800°C, were characterized by means of their ir spectra (from 400 to 3700 cm^{-1}). The conclusions, which were made from the spectra, were compared with the results of earlier chemical, x ray, and reflection spectra measurements. (auth)

871 ON THE CONSTITUTION OF SOME SYSTEMS HOMOLOGOUS AND QUASI-HOMOLOGOUS TO T^5–Ga. I. THE SYSTEMS VANADIUM–GALLIUM, NIOBIUM–GALLIUM AND TANTALUM–GALLIUM AND THE STRUCTURE OF $Ti_6Sn_5(H)$. Meissner, Hans-Georg; Schubert, Konrad (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 56: 475-84(July 1965). (In German).

In the system vanadium–gallium the following structures were determined: V_6Ga_5 ($Ti_6Sn_5(h)$-type), VGa(h) (Cu_5Zn_8-type), and V_3Ga_5 (Mn_2Hg_5-type). In the system niobium–gallium the following structures were determined: Nb_5Ga_3 (W_5Si_3-type), Nb_5Ga_4 (Ti_5Ga_4-type), Nb_5Ga_{13} (Nb_5Ga_{13}-type), and $NbGa_3$ ($TiAl_3$-type), and in the system tantalum–gallium: Ta_5Ga_3 (W_5Si_3-type) and a phase similar to Nb_5Ga_{13}. Also, some oxide structures of the systems were determined. The structure of $Ti_6Sn_5(h)$ was also determined. (auth)

872 THE COMPOSITION OF GASES EVOLVED DURING ELECTRON BEAM MELTING OF VANADIUM, NIOBIUM, AND TANTALUM. Fromm, Eckehard (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 56: 493-7(Aug. 1965).

Melt experiments were performed on pretreated powder-press-compacts of niobium and tantalum weighing 10–20 g, and vanadium granules in the electron beam furnace by varying the time of melting. In addition to the gas determination of the specimens before and after melting, the gases evolved during the melting process were analyzed. The gas content of the specimens was not reduced after two to five minutes stay at melting, although a large quantity of gas was still evolved. Nearly 80 vol % of this gas consists of hydrogen. This is supposedly owing to the decomposition of water vapor. (auth)

873 SHAPING BY POWDER METALLURGICAL METHODS AND CERTAIN PROPERTIES OF INTERMETALLIC COMPOUNDS OF URANIUM. Ondracek, Gerhard Petzow, Guenter (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 56: 498-502(Aug. 1965). (In German).

The electrical, thermal, and thermo-electrical properties of some Laves phases of uranium were investigated. Useful densities (≥90%) of sintered specimens can be obtained by cold pressing (8 to 10 tons/cm^2) and sintering in vacuum (10^{-5} to 10^{-4} Torr). The ratio of the absolute temperatures of the beginning of sintering and the melting temperatures lies at 0.88 ± 0.02 with the exception of UAl_2. These high values can be related to the crystal structure of the Laves phases. The course of the isothermal sintering curves suggests an explanation of the processes based on solid state diffusion. The electric resistivity of uranium containing Laves phases was higher than that of their pure components. The coefficients of thermal expansion as function of the temperature are higher in the phases with aluminium and manganese than in those with cobalt and iron. UAl_2 shows a considerably higher work function (4.2 ev) than proximate solid solutions of the uranium-aluminum phase diagram. (auth)

874 A CONTRIBUTION TO THE CONSTITUTION OF URANIUM-RICH URANIUM–COBALT–MANGANESE ALLOYS. Petzow, Guenter (Max-Planck-Institut fuer Metallforschung, Stuttgart); Sampaio, Oliveria A. Z. Metallk., 56: 503-8(Aug. 1965). (In German).

The system U-UCo_2-UMn_2 was investigated using metallographic, thermal, dilatometric, chemical and x-ray methods. Isothermal sections at 700 and 600°C and four temperature-concentration sections were worked out and present a good survey of the phase spaces. Two non-

variant 4-phase equilibria were found at 750 and 690°C. U_6Co and U_6Mn exhibit complete solid solubility. The solubility of ternary additions in UCo and α-U is practically nil, and in β-U and γ-U is small. (auth)

875 THE TEMPERATURE DEPENDENCE OF TORSION FATIGUE STRENGTH IN TUNGSTEN CARBIDE–COBALT ALLOYS. Dawihl, Walther; Altmeyer, Georg (Univ., Saarland, Ger.). Z. Metallk., 56: 512-15(Aug. 1965). (In German).

Measurements of torsion fatigue strength in alloys with 6 and 20 wt-% Co indicated for both alloys a maximum for the former at 600°C, for the latter at 300°C. This maximum supports the assumption, that the maximum in the wear-speed curves is predominantly due to recovery processes in the edge of the tool materials. (auth)

876 STRUCTURE OF NIOBIUM SUBOXIDE (Nb_4O) REVEALED BY ELECTRON DIFFRACTION. Steeb, Siegfried; Renner, Joerg (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 56: 531-4(Aug. 1965). (In German).

Electrolytically thinned films of single crystals of niobium were treated with oxygen of 5×10^{-4} Torr at about 500°C. Electron diffraction diagrams of these films were obtained and evaluated. The results show that Nb_4O was formed, which crystallizes in a tetragonal lattice (a = 6.65 Å, c = 3.32 Å, c/a = 0.5). Each elementary cell of Nb_4O contains four subcells. These subcells are built up according to the L'20-(martensitic-) type, with $\frac{1}{3}$ of the possible interstitial sites occupied by oxygen. The atomic positions of the phase Nb_4O are given. Also a summary of all the crystallographic data in the system niobium-oxygen obtained so far is included. (auth)

877 AIAA FIFTH ANNUAL STRUCTURES AND MATERIALS CONFERENCE, PALM SPRINGS, CALIFORNIA, APRIL 1–3, 1964. AIAA Publication CP-8. New York, American Inst. of Aeronautics and Astronautics, 1964. 483 p. $15.00. (CONF-640412).

Forty-four articles are included; separate abstracts were prepared for 3. One article on Al–Be alloys was previously abstracted in NSA as 19: 37188. The remaining 40 articles include information on: materials and structures for use in space vehicles. (P.C.H.)

For abstracts of individual papers see: 878, 879, and 910.

878 THERMAL PROPERTIES OF FIFTEEN REFRACTORY MATERIALS. Hedge, J. C.; Kostenko, C.; Lang, J. I. (IIT Research Inst., Chicago). pp 105-19 of AIAA Fifth Annual Structures and Materials Conference. AIAA Publication CP-8. New York, American Inst. of Aeronautics and Astronautics, 1964.

The thermal conductivity, specific heat, and linear thermal expansion of 15 refractory materials was determined from room temperature to the melting point, or 5000°F, whichever was lower. The materials investigated were B_4C, ZrN, BeO, spinel, six Nb alloys, three Ta alloys, and two Mo alloys. Descriptions are given of the equipment used. Calibration measurements were conducted with several materials whose thermal conductivity, specific heat, and density had been accurately determined and the results of the thermal diffusivity measurements agreed within ±5% of the calculated value. Data are tabulated. (P.C.H.)

879 A METALLURGICAL EVALUATION OF NEW TUNGSTEN PRODUCT. Maykuth, D. J.; Ratliff, J. L.; Ogden, H. R. (Battelle Memorial Inst., Columbus, Ohio). pp 126-31 of AIAA Fifth Annual Structures and Materials Conference. AIAA Publication CP-8. New York, American Inst. of Aeronautics and Astronautics, 1964.

Unusual metallurgical characteristics observed for this new tungsten product, both in its as-produced form and after consolidation and fabrication to a sheet product, are summarized. The product consists of individual tungsten spheres with a size range of 200 to 600 μ and a typical average diameter of about 475 μ. Because of their size, shape, and relatively high hardness, the as-produced granules are not amenable to consolidation using normal cold compacting techniques. Thus, the granules cannot be compacted into cohesive, massive shapes using conventional steel dies or isostatic compaction in elastic containers. (P.C.H.)

880 A STUDY OF SOME NONSTOICHIOMETRIC RARE-EARTH OXIDES [Thesis]. Miller, Albert Eugene. Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 95p.

Rare-earth sesquioxides, RE_2O_3, were partially reduced by melting in a vacuum or by co-melting with a rare-earth metal to produce previously unreported rare-earth oxides of the type REO_x, x < 1.500. The oxygen to metal ratio of these materials was determined from the weight gained upon reoxidation to the sesquioxide, RE_2O_3. An insight into the nature of these materials was gained through x-ray diffraction, density, and magnetic investigations of monoclinic (B-type) $GdO_{1.493}$ and the cubic (C-type) forms of $GdO_{1.495}$, $YO_{1.491}$, $ErO_{1.489}$, and $LuO_{1.485}$. A vibrating-sample magnetometer was constructed, calibrated, and used to determine the paramagnetic susceptibility of cubic $GdO_{1.495}$ and cubic $ErO_{1.489}$ as a function of temperature from 4.2–300°K at several different magnetic fields. In addition, a mutual inductance method was used to determine the magnetic susceptibility of these materials under an essentially zero-field condition from ca. 1.3–300°K. The x ray and density data showed that the nonstoichiometry obtained in the partially reduced rare-earth sesquioxides could be attributed entirely to the loss of oxygen from the lattice. The magnetic investigations of cubic $GdO_{1.495}$ and cubic $ErO_{1.489}$ showed that these materials deviate in a complex manner from the normal Curie-Weiss behavior observed for cubic Gd_2O_3 and cubic Er_2O_3. It was found that the paramagnetic susceptibility of these materials increased linearly with increasing magnetic field. (Dissertation Abstr.)

881 A MASS SPECTROMETRIC INVESTIGATION OF TUNGSTEN DIOXIDE AND TUNGSTEN TRIOXIDE [Thesis]. Battles, James Everett. Columbus, Ohio, Ohio State Univ., 1964. 71p.

The sublimation behavior of the W-WO_2-vapor and WO_3-$W_{20}O_{58}$-vapor systems was investigated by means of mass effusion and mass spectrometric observations. The temperature range of this study was 1270-1420°K and 1370-1530°K for the solid systems WO_3-$W_{20}O_{58}$ and W-WO_2, respectively. The condensed phases were identified by x-ray diffraction. The parent vapor species in the W-WO_2-vapor system are W_2O_6, W_3O_9, and W_4O_{12} with appearance potentials of 12.73, 12.45, and 12.21 electron volts, respectively. In the WO_3-$W_{20}O_{58}$-vapor system, the ion W_2O_6 was predominantly a fragment of the other parent species. The gaseous molecule W_5O_{15} is a parent species, but mass spectrometric measurements could not be made because of its low concentration. The partial pressures of the parent species were determined from a combination of the mass effusion data and mass spectrometric measurements of the ion currents as a function of temperature. The equations for the partial pressure in atmospheres as a function of temperature for the WO_3-$W_{20}O_{58}$-vapor system and for the W-WO_2-vapor system are given. The standard entropies of the gaseous species were calculated to be 165.6, 224.2, and 285.6 cal./mole-°K at 1500°K for W_2O_6, W_3O_9, and W_4O_{12}, respectively. The standard free energy of reaction as a function of temperature was evaluated from the partial pressure data and consideration of the several equilibria established in the vapor phase. The product in the reaction of water vapor with WO_3 or WO_2 was mass spectrometrically identified as the hydrate $WO_3 \cdot H_2O$. The standard heat of formation was evaluated to be 31.4 Kcal $mole^{-1}$ over the temperature range of 1330-1450°K. (Dissertation Abstr.)

882 PREDICTION OF HIGH-TEMPERATURE METALLIC PHASE DIAGRAMS. Brewer, Leo (Univ. of California, Berkeley). pp 12-103 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965. (UCRL-10701 (Rev.)); (UCRL-10701(Rev.2)).

Predictions of the multicomponent phase diagrams for the 30 metals of the three transition series from K through Ni, Rb through Pd, and Cs through Pt are presented. The Engel

correlation between electronic configuration and crystal structure is used together with the regular solution theory of solubilities to predict the structures of the various phases of a diagram and their ranges of composition. One-hundred-fifty-four references and 30 diagrams are given. (W.L.G.)

883 THE CRYOGENIC PROPERTIES OF METALS. Conrad, H. (Franklin Inst., Philadelphia). pp 436-509 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965.

The mechanical properties at low temperatures of some common metals in each of the three crystal structures (bcc, fcc, hcp) were reviewed for the purpose of establishing those properties of the base material that leads to the most desirable combination of high strength and ductility. The properties of single crystals and the effects of alloying were not considered. (W.L.G.)

884 FIBER-STRENGTHENED MATERIALS. Kelly, A.; Tyson, W. R. (Cambridge Univ., Eng.). pp 578-602 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965.

The mechanical properties of fiber-strengthened composites are reported and results of examinations of the interactions between the tungsten fibers and the copper matrix during testing are discussed. (W.L.G.)

885 PREDICTIONS OF MACROSCOPIC FLOW CHARACTERISTICS FROM DISLOCATION BEHAVIOR IN GRAPHITE. Williamson, G. K. (Central Electricity Generating Board, Berkeley, Eng.). pp 651-68 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965.

The simplicity of the dislocations in polycrystalline graphite permit it to deform by dislocation movement in a pseudoelastic manner. Graphite fails to achieve the strength it intrinsically possesses because of the ease of shear by dislocation movement and because such sheaf cannot relieve the stress concentrations that cause tensile fracture of the basal planes. Though graphites can be strengthened by any process that impedes dislocation movement, such strengthening will have little effect on the ductility at fracture. When pyrolytic graphite is stressed in tension, it is possible that the resulting nonuniform stress distribution is relieved slowly at high temperatures by diffusional creep, giving a gradual improvement with time of the stress to fracture. By incorporating thin flakes or whiskers in a ductile matrix, it may be possible to utilize graphite's strength to produce a tough as well as strong structure. (W.L.G.)

886 DEFORMATION BEHAVIOR OF REFRACTORY COMPOUNDS. Coble, R. L. (Massachusetts Inst. of Tech., Cambridge). pp 706-23 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965.

The deformation behaviors of Al_2O_3, BeO, SiC, and NaCl are summarized and the calculated diffusion coefficients for diffusional creep compared with measured diffusion coefficients. The problems associated with precise interpretation of diffusional deformation are illustrated. (W.L.G.)

887 THE SOURCES OF STRENGTH AND BRITTLENESS IN INTERMETALLIC COMPOUNDS. Westbrook, J. H. (General Electric Co., Schenectady, N. Y.). pp 724-68 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965.

The strengthening mechanisms that may operate in intermetallic compounds and the experimental evidence for many of these mechanisms were summarized. Ninety-two references are given. (W.L.G.)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry

Refer also to abstract 782.

888 (BMI-1731) RADIATION STABILITY OF URANIUM MONONITRIDE. Martin, Robert L.; Zielenbach, William J.; Storhok, Victor W.; Keller, Donald L.; Gates, John E. (Battelle Memorial Inst., Columbus, Ohio). June 29, 1965. Contract W-7405-eng-92. 31p. (EURAEC-1431). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Work Performed under United States—Euratom Joint Research and Development Program.

The irradiation characteristics of UN fabricated by various techniques and clad with Type 316L stainless steel were studied at surface temperatures up to about 750°C and fission burnups to 6.3 at. % (2.2×10^{21} fissions per cm^3) of the uranium. Diametral swelling of clad specimens varied from 1.3 to 4 per cent. No clear-cut relationships between swelling characteristics and fabrication technique were observed. Fractional fission-gas releases ranged up to 26 per cent. Hydrogen resulting from $^{14}N(n,p)^{14}C$ reaction was almost totally released from the UN but significant fractions were retained within soundly clad specimens. About half of the stainless steel claddings exhibited very small cracks of unknown origin. (auth)

889 (BNWL-120, pp 4.1-59) REACTOR METALS RESEARCH. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Hastelloy N, Hastelloy X-280, Incoloy 800, and Inconel 600 were irradiated at elevated temperatures and tested in tension at temperatures to 650°C. In the case of Hastelloy N irradiated at 280°C, both strength and ductility at 650°C were reduced with neutron exposure. For specimens irradiated at 740°C, the 650°C ductility was one-third of that at room temperature after an exposure of 1.9×10^{20} nvt. The net loss in ductility due to irradiation is greater at room temperature. Incoloy 800, irradiated at 740°C in the solution treated, mill annealed, and 20% cold worked conditions, showed a higher retained ductility in the solution treated condition at 650°C. A greater loss in strength was also found. Specimens of Hastelloy X-280 were irradiated at 280 and 740°C in the solution treated condition. Results of tests performed at 650°C show a loss in strength and ductility for specimens irradiated at both temperatures. The percent uniform elongation for specimens irradiated at 740°C were considerably below those irradiated at 280°C. Minimum creep rates of the in-reactor creep of annealed type 304 stainless steel were compared to those determined out-of-reactor as a function of temperature and stress. No effect of neutron irradiation on the minimum creep rate was found. Elongation at rupture and rupture life were reduced in-reactor to approximately 40% of that observed out-of-reactor. The difference in the activation energies suggests an irradiation modification of the primary stage of in-reactor creep. With the conclusion of Engineering Test Reactor (ETR) Cycles 71 and 72, approximately 100 tensile, stress-rupture, and fracture specimens have been discharged from ETR core positions. Materials irradiated at 50 and 290°C include nickel-base alloys, stainless steels, and Zircaloy-2. The retrieval portion of the REM Computer Program was programmed, debugged, and utilized to generate trial reports. This program provides for editing, processing, storage, and retrieval of tensile and associated metallurgical test data. A series of tensile tests on types 348 and 304 stainless steel were completed at test temperatures from 20 to 850°C. The data include results obtained from materials irradiated at temperatures of 60, 290, and 750°C. Specimens were tested in the as-fabricated condition, after exposure in a controlled environment, and after irradiation exposures greater than 1.0×10^{21} nvt (>1 Mev). The results of these tests identify the ranges of test temperatures at which ductility minimums exist. Hastelloy X-280 tensile specimens having various combinations of cold work and aging treatments were irradiated at 540°F to 1×10^{20} nvt and, with their control, were tensile tested at room temperature and 1350°F in air. When compared with a standard treated irradiated material, some treatments showed improved high temperature ductility while maintaining strength, and susceptibility to radiation damage was lessened. One treatment resulted in an 84% increase in postirradiation high temperature yield strength with little ductility reduction. A maximum room temperature yield strength increase of 63% was also obtained while maintaining useful ductility of 18%. The double cantilever beam (DCB) type of specimen has the advantage

of enabling a relatively large number of plane strain fracture toughness data to be determined from a single specimen of moderate size. Since recalibration of the compliance of the specimen is made necessary by change in specimen design, a number of tests to determine the effect of changing the geometry on the compliance curves were performed. These tests also observed the effects of changing the geometry on the value of the fracture toughness for the material studied. The material selected for these tests was 7075-T6 aluminum. The variables studied were gross thickness (B), beam depth, side groove depth, and side groove root radius. The compliance was computed from the slope of the load versus extension curve. It was found that the compliance could be represented by: $\varphi = Ac^n$, where φ is the compliance, c is the crack length, and A and n are constant for a given set of specimen dimensions. The compliance results indicate that A is inversely proportional to the moment of inertia of the arms for a given beam depth and n decreases with increasing beam depth. The fracture toughness or K_{IC} was found to increase when the net width to gross width ratio became very small. For the specimens with large beam depth but narrow width, K_{IC} was found to decrease with crack length. It was found that increasing the side groove root radius resulted in the formation of shear lips along the side of the crack. Concurrent with shear lip formation, the K_{IC} values tended to increase. The methodology of fracture mechanics is being applied to the study of delayed failure of pressure vessel steels. Analytic techniques, using a DCB specimen, are being developed to describe the fracture process in terms of its thermodynamic properties. The change in these properties with varying hydrogen content will be measured. (W.L.G.)

890 (EXP-NRX-21406) THE RELEASE OF FISSION GASES AND IODINES FROM DEFECTED UO_2 FUEL ELEMENTS OF DIFFERENT LENGTHS. Allison, G. M.; Rae, H. K. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). June 1965. 22p. (AECL-2206). Dep.; AECL $0.50.

An interpretation is presented of results obtained on the release of fission gases and iodines from defected UO_2 fuel elements of different lengths irradiated in the X-214 test. The observed release of the fission gases suggested a model in which resistance to radial movement and to axial movement are treated separately. The released gas is assumed to come only from the hot central core. First a small fraction of the production is assumed to move readily from the hot core into cracks in the colder UO_2 and then axial movement occurs such that the fractional release is a unique function of the product of length and decay constant. The release of iodines is lower because they are delayed for a long time between leaving the hot zone and reaching the defect. The fraction released is proportional to $\lambda^{-\frac{1}{2}}$. The long delay outside the hot core is an important source of ^{135}Xe and ^{133}Xe and their release is enhanced accordingly. (auth)

891 (GEAP-3893) POST-IRRADIATION EXAMINATION OF ORNL-ETR CAPSULES E-9 AND E-12. Darmitzel, R. W. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1962. Contract W-7405-eng-26; Subcontract ORNL-1350. 55p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

For Oak Ridge National Lab., Tenn.

Post-irradiation examination of two full-diameter Experimental Gas Cooled Reactor prototype capsules was performed. The capsules contained twelve hollow pellets of enriched, high density, uranium dioxide fuel clad in 304 stainless steel. Beryllium oxide cores filled the central voids in the fuel and a magnesium oxide spacer was placed at each end of the fuel stacks. Operations performed in the examination included cladding examinations, gamma scanning, fission gas analyses, void volume determinations, capsule disassembly, fuel examinations, density measurements, burnup analyses, metallographic examinations, x-ray diffraction analyses, and microhardness determinations. Severe fracturing of the fuel pellets in Capsule E-9 had occurred. A grain boundary precipitate was observed in the cladding from Capsule E-9, and sigma phase iron was present in significant amounts in the cladding of Capsule E-12. Several second phases were detected in the fuel material from both capsules. (auth)

892 (GEAP-4804) EXPERIMENTAL STUDIES OF TRANSIENT EFFECTS IN FAST REACTOR FUELS. SERIES II. MIXED OXIDE (PuO_2-UO_2) IRRADIATIONS. Hanson, J. E.; Field, J. H.; Rabin, S. A. (General Electric Co., San Jose, Calif. Advanced Products Operation). May 1965. Contract AT(04-3)-189. 96p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The results of an experimental program to evaluate the performance of non-pre-irradiated fast ceramic reactor fuel under conditions simulating accidental power excursions are presented. Results from three experiments in the TREAT facility using 0.250-inch OD., Type 347 stainless steel clad, 20 weight percent PuO_2–80 weight percent UO_2 fuel specimens are interpreted with regard to fuel-cladding temperatures, fuel vapor pressure, thermal expansion of the fuel, and cladding integrity. Incipient failure limits for axially unrestrained fuel are identified as functions of the maximum fuel and cladding temperatures attained during the transient. (auth)

893 (GEAP-5100A) HIGH PERFORMANCE UO_2 PROGRAM. IRRADIATION OF 0.5 INCH DIAMETER, SOLID PELLET UO_2 FUEL RODS AT 700,000 BTU/H-FT^2 PEAK HEAT FLUX. Lyons, M. F.; Nelson, R. C.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 1965. Contract AT(04-3)-189. 187p. (EURAEC-1478). Dep. mn; CFSTI $5.00 cy, $1.00 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and the complete, correlated post-irradiation examination results are described for a four-rod fuel assembly, designated EPT-6, that operated in the GETR-PWL with slight central melting to a burnup of ~1200 Mwd/te. The fuel rods were unsegmented, reactor-length rods containing 95% dense, solid, sintered UO_2 pellets in freestanding Zircaloy-2 cladding. This fuel assembly was the first of a series irradiated to investigate the feasibility and limitations in UO_2 fuel-rod operation with central melting. Post-irradiation examination of this assembly provided the first indication of the basic obstacle to operation with central melting; namely, severe, localized clad swelling accompanying the onset of central melting in high density fuel. (auth)

894 (RT/CHI(65)27) URANIUM AND FISSION PRODUCTS RELEASE FROM URANIUM DIOXIDE. Lepscky, C.; Segre, G.; Cesarano, C.; Ferrari, S.; Giaquinto, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). June 1965. 21p. Dep. mn.

Two series of experiments were carried out to study the release of U and other fission products caused by superficial fission during low temperature irradiation. The first type of experiment studies the release of U from surfaces of UO_2 pellets utilizing a catcher technique; the number of U atoms emitted per fission fragment is determined by measuring the α activity of the catcher. The second type determines the release of some solid and gaseous fission products (^{95}Zr, ^{103}Ru, ^{137}Cs, ^{144}Ce, ^{85}Kr, ^{131m}Xe, ^{133}Xe) by means of irradiation of fused UO_2 grains dispersed in metallic sodium and subsequent measurement of fission product distribution in the two phases. The results are discussed and compared and the experimental techniques are described. (auth)

895 THE COMBINED EFFECT OF CARBON AND NEUTRON RADIATION ON MOLYBDENUM. Mastel, B.; Brimhall, J. L. (Battelle Memorial Inst., Richland, Wash.). Acta Met., 13: 1109-16(Nov. 1965).

The formation of defect clusters, spots and loops, in molybdenum due to neutron irradiation at 40°C was studied by transmission electron microscopy. Carbon promoted the heterogeneous nucleation of clusters and is responsible for the formation of resolvable dislocation loops. A saturation level in the density of spots and loops was attained after an exposure of approximately 10^{19} nvt, independent

of the carbon concentration, and further irradiation produced defect interaction and a complex damage state. Annealing of the irradiated samples resulted in a decrease in the density of small spots and an increase in the density and size of the resolvable dislocation loops. The loops were identified as being interstitial in character; the spot clusters were inferred to be interstitial also. (auth)

896 POINT DEFECT HARDENING OF ALUMINUM. I. YIELD STRESS INCREASE DUE TO ELECTRON IRRADIATION AT 23°K. Ono, Kanji; Meshii, M. (Northwestern Univ., Evanston, Ill.). Acta Met., 13: 1123-30 (Nov. 1965). (TID-21519).

Aluminum single crystals of 99.999% initial purity were irradiated at 23°K or below with 1.0 Mev electrons to a total dosage of $0.5 \sim 10 \times 10^{16}$ e/cm^2. Stress curves of irradiated crystals were drastically different from those of annealed crystals. Yield stress was increased by a factor of about eight by irradiation to a total dosage of 10^{17} e/cm^2. Extension of easy glide was greatly prolonged and slip lines of crystals were coarsened by the irradiation. No appreciable change in the work hardening rate in the glide region was found. A sharp yield point was not observed and the transition from elastic to plastic behavior was gradual in all cases following the irradiation. The increase in the yield stress, $\Delta\tau$, was found to exhibit a square-root dependence on the defect concentration, c; namely, $\Delta\tau \cong G\, c^{1/3}$, where G was the shear modulus. Under the experimental conditions, only dispersed interstitials and vacancies were introduced by the irradiation. Several mechanisms of hardening were examined on the basis of the observed effects. Since dispersed vacancies were known to produce little hardening, the results were concluded to be due to the dispersed interstitials. At present, no theory is capable of explaining the observations quantitatively. The theories based on the dispersed barrier model appeared to be the most favorable, as they predicted the square-root dependence of $\Delta\tau$ on the defect range concentration in the most convincing manner. (auth)

897 MODULUS EFFECTS IN METALS AFTER LOW TEMPERATURE ELECTRON IRRADIATION. I. Cu. Keefer, D.; Robinson, J. C.; Sosin, A. (Atomics International, Canoga Park, Calif.). Acta Met., 13: 1135-52(Nov. 1965).

A study of electron irradiated Cu was made by means of modulus measurements. Damage production data obtained at 20°K were analyzed in terms of a two dislocation model and compared with damage data taken at 77°K. Analysis of the data yields information on the types of dislocations which are being pinned by radio-induced point defects and the relative effectiveness of these dislocations as sinks for defects which arrive both dynamically during irradiation (20°K) as well as thermally (77°K). Information was also obtained concerning the range over which defects can travel dynamically. Detailed isochronal annealing studies were made following 20°K irradiations at various electron energies. After irradiation at sufficiently high electron energies, isochronal measurements showed three dislocation pinning stages; these were centered at approximately 55°K (Stage I), 225°K (Stage III), and 300°K (Stage IV). The magnitude of Stage I relative to that of Stage III decreased sharply with decreasing electron energy. This result suggests that the defect responsible for Stage I is a separate entity from that responsible for Stage III. A two interstitial model was used in explaining Stages I and III; Stage IV is attributed to vacancies. Results of quenching studies substantiate the latter assignment. Migration of defects to dislocations in Stages I and III was found to occur with a $\frac{2}{3}$-dependence on annealing time. The activation energy for migration in Stage III is about 0.6 ev while that in Stage IV was approximately 1.0 ev. A model for crowdion motion to dislocations in Stage I is outlined. (auth)

898 IRRADIATION EMBRITTLEMENT OF LOW-BORON TYPE 304 STAINLESS STEEL. Martin, W. R. (Oak Ridge National Lab., Tenn.); Weir, J. R.; McDonald, R. E.; Franklin, J. C. Nature, 208: 73-4(Oct. 2, 1965). (ORNL-P-1105).

The effects of very small concentrations of boron on the irradiation embrittlement of type 304 stainless steel irradiated to a high exposure in a thermal neutron test reactor are described. Only small variations were found in the ductilities of all electron-beam melted heats, although an order of magnitude existed between the concentrations of boron. The concentrations of helium were calculated for the ^{10}B reaction for each of the alloys. Considering the helium from all sources, the lack of variation in ductility of the electron-beam melted heats is more easily explained since the difference in total concentration is less than a factor of 2. It was concluded that removing the ^{10}B from the alloy is not the ultimate solution for improving the ductility of irradiated alloys. (P.C.H.)

899 FISSION-GAS RELEASE FROM PYROLYTIC-CARBON-COATED FUEL PARTICLES DURING IRRADIATION AT 2000 TO 2500°F. Reagan, P. E.; Morgan, J. G.; Sisman, O. (Oak Ridge National Lab., Tenn.). Nucl. Sci Eng., 23: 215-33(Nov. 1965).

The fission-gas release from pyrolytic-carbon-coated fuel particles during irradiation was studied for gas-cooled reactor application. Duplex- and triplex-type coatings on thorium-uranium carbide cores and on uranium carbide cores were tested at temperatures between 2000 and 2500°F (1093 and 1371°C). Both types of coatings retained fission gas quite well up to about 20 at.% heavy-metal burnup. Postirradiation examination revealed that the particles with the duplex coating were more susceptible to radiation damage (by the formation of a reaction zone at the core/coating interface) than were the particles with the triplex coating. This damage, however, did not affect the fission-gas release rates. (auth)

900 INFLUENCE OF IMPURITIES ON THE RECOVERY OF ELECTRON IRRADIATED GOLD. Bauer, W. (Atomics International, Canoga Park, Calif.). Phys. Lett., 19: 180-1(Oct. 15, 1965).

The effect that residual (<0.01%) impurities have on the resistivity recovery of point defects generated by electron irradiation was investigated. The possibility of explaining the recovery of selectively doped gold within the recovery model formulated for gold by Bauer and Sosin (Phys. Rev., 136: A474(1964)) was also considered. (D.C.W.)

901 AN EXTENDED APPROXIMATION OF BORN-MAYER SCATTERING CROSS-SECTIONS FOR RADIATION DAMAGE CALCULATIONS. Vajda, P. (Danish AEC Research Establishment, Risoe). Phys. Lett., 19: 204-5 (Oct. 15, 1965).

A previously developed cut-off method is extended by approximating the Born-Mayer potential with the potential $V_{co}(r) = A(r_c/r - 1)^2 + B(r_c/r - 1)$ for $r \leq r_c$ and $V_{co}(r) = 0$ for $r \geq r_c$, where A and B are parameters and r_c is a fixed cut-off radius chosen to be $0.5(2)^{0.5}$ lattice constant. Numerical results for Cu-Cu interactions are included. (D.C.W.)

902 STAGE III ANNEALING IN PROTON-IRRADIATED NOBLE METALS. Dworschak, F.; Koehler, J. (Univ. of Illinois, Urbana). Phys. Rev., 140: A941-53 (Nov. 1, 1965). (COO-1198-276).

Pulsing and annealing data are given for 99.999% pure copper specimens which were proton irradiated at 90°K. It is shown that stage II obeys first-order annealing kinetics and that the structure observed is probably not associated with impurities. Stage III obeys second-order kinetics, and its activation energy in the case of copper is not dependent on dose in the range $\Delta\rho_0 = 3 \times 10^{-9}\ \Omega$ cm to $\Delta\rho_0 = 3 \times 10^{-8}\ \Omega$ cm. Pulsing experiments in which samples are heated in a msec from –50°C to temperatures up to 230°C and held for 30 msec before quenching show no evidence for any change in the annealing process (i.e., the results can be predicted assuming E_M^{II}(Cu) = 0.71 ev and using second-order kinetics). It is shown that if di-interstitial migration is responsible for stage III then the binding en-

ergy of di-interstitials exceeds 1.0 ev in copper. If, conversely, two kinds of interstitials migrate in stages I and III, then the pulsing experiment suggests that the barrier preventing conversion of the stage III type to the stage I type is greater than 1.14 ev in copper. No evidence for vacancy migration in proton-irradiated silver is observed during annealing at temperatures above state III. Existing models suggested to explain the annealing of irradiation damage are reviewed. (auth)

903 EVIDENCE OF DIFFERENT TYPES OF F CENTERS FROM THERMOLUMINESCENCE STUDIES IN X-IRRADIATED ALKALI HALIDES. I. HIGHLY PURE KCl CRYSTALS. Jain, S. C.; Mehendru, P. C. (National Physical Lab., New Delhi, India). Phys. Rev., 140: A957-71(Nov. 1, 1965).

Two thermoluminescence peaks are observed at 135 and 190°C in highly pure KCl crystals (divalent impurity concentration <1 ppm) x-irradiated at room temperature and heated at 40°C/min. The growths of the areas Δ_1 and Δ_g under the first and the second peaks, with the time of x irradiation, are found to obey the equations given by Mitchell, Wiegand, and Smoluchowski for the growth of the concentrations f_1 and f_g of the first-stage and the second-stage F centers, respectively. From this result and from the observation that the ratio $\Delta_1/f_1 = \Delta_g/f_g$ remains constant in a variety of crystals, it is concluded that all the thermoluminescence is due to F centers and that the 135 and 190°C peaks correspond separately to the bleaching of the first-stage and the second-stage F centers, respectively. The values of the parameters in the equations given by Mitchell et al. are derived from the observed growths of Δ_1 and Δ_g and are found to be in agreement with the values obtained by Mitchell et al. The reduction in the area under the thermoluminescence curve on partial optical or thermal bleaching is found to be proportional to the reduction in the F-center density. However, optical bleaching reduces both thermoluminescence peaks, whereas thermal bleaching up to about 100°C reduces mainly the first peak. It is found that complete thermal bleaching does not destroy all the vacancies generated during the irradiation but disperses some of them more uniformly. The results are not inconsistent with the view that the first-stage F centers are formed by the vacancies present in the crystal prior to irradiation and are distributed uniformly in the crystal, and that the second-stage F centers are formed by the vacancies generated in the crystal during the irradiation process, perhaps near a defect, and are present in small regions of high local concentrations. (auth)

904 RADIATION DEFECTS IN SEMICONDUCTORS. Vavilov, V. S. (Lebedev der Akademie der Wissenschaften, Moscow). Phys. Status Solidi, 11: 447-97(Oct. 1965). (In German).

Theoretical interpretations are given of the formation and the nature of radioinduced defects in semiconductors. The defects produced by fast electrons and gamma radiation, the characteristics of the formation of Frenkel defects in diamond-type crystal lattices, and the defects due to fast neutrons and heavy charged particles are studied. Experimental investigations are discussed; in particular, the determination of the threshold energy for the production of defects in silicon and germanium as well as determination of the energy level spectra for defects in silicon. Attention is given to the optical and photoelectric methods. The interaction between radioinduced defect and impurity atoms and the effect on the stability of the defects are investigated. (L.B.S.)

905 RECOVERY OF Al–Si ALLOYS NEUTRON IRRADIATED AT 78 deg K. Ceresara, S.; Federighi, T.; Pieragostini, F. Phys. Status Solidi, 11: 779-87(Oct. 1965).

A set of Al–Si alloys (0.1 to 0.78 at. % Si) are neutron-irradiated at 78°K at a fast dose (E > 1 Mev) of 1.2×10^{18} n/cm^2. The recovery of electric resistivity is then investigated by isochronal and isothermal annealing. The results are compatible with the view that both interstitials and vacancies interact with Si atoms. The former are trapped during irradiation at 78°K and are released; the latter are trapped during their annealing, forming mobile Si-vacancy couples which, in turn, either migrate to small interstitial clusters where vacancies annihilate, or combine one another, giving rise to complex aggregates which are eliminated in stage IV. (auth)

906 ON THE SIGNIFICANCE OF ELECTRON MICROSCOPIC CONTRAST APPEARANCE OF DEFECT AGGLOMERATES IN NEUTRON-IRRADIATED COPPER. Ruehle, M.; Wilkens, M.; Essmann, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart; Technische Hochschule, Stuttgart). Phys. Status Solidi, 11: 819-29(Oct. 1965). (In German).

Contrast experiments of Essmann and Wilkens on neutron-irradiated copper indicate that the black-white contrasts observed were due to small Frank dislocation loops. To explain this the electron microscope contrast of this kind of defects is calculated as a function of loop depth within the foil, of dimensions of loops, and of the electron microscope focusing conditions. Comparison of theory with experiment shows that other defects apart from those induced by radiation damage are present. To demonstrate this, nonirradiated, well annealed monocrystalline copper foils are investigated. Depending on the polishing conditions, different numbers of contrasts having the same properties as Frank loops are observed in these samples. However, they lie only near the sample surface turned to the electron gun. Under well defined polishing conditions, disturbing contrasts are eliminated. The properties of remaining contrasts in neutron-irradiated copper agree with the calculations. (auth)

907 FUEL ELEMENTS. Power Reactor Technol., 8: No. 3, 172-5(Summer 1965).

Work on the irradiation stability of metal-clad μ-case ceramic fuel elements is summarized. Results of tests on stainless steel and Zircaloy cladding materials are summarized, and especial attention is directed to the evaluation of Incoloy 800 used as cladding for superheat reactor fuels. (J.R.D.)

908 RADIATION DAMAGE ON GERMANIUM, SILICON, AND III-V SEMICONDUCTORS. Kaiser, Rudolf. Z. Angew. Physik., 19: 270-9(1965). (In German).

Significant results were made in the interpretation of the lattice perturbations produced by irradiation in semiconductors. This is especially true for Si, in which various atomic perturbations, partially in connection with foreign atoms, were established using spin resonance studies. In Ge, irradiation experiments at the temperature of liquid He has given significant clarifications on the primary perturbation sites and on their dependence on the site of the Fermi levels (n- or p-conducting material). In the group of the III-V semiconductors the assignment in InSb of the two strongest temper stages was made to the impurities of InSb atoms with their voids induced by irradiation with electrons which impinge under given crystallographic directions on the lattice. The electron irradiation of GaSb yields indications for the lattice perturbations present in nonirradiated crystals, which lead in GaSb to the high carrier concentration of approximately 10^{17}/cm^3. Results on GaAs and InAs were also reported. (tr-auth)

909 MEASUREMENT OF THE CHANGES OF THE ELECTRIC RESISTANCE OF GOLD BY IRRADIATION WITH MONOENERGETIC PROTONS OF VARIABLE ENERGY. Schmidtke, Martin (Technische Hochschule, Munich). Z. Phys., 188: 165-6(1965). (In German).

Gold foils of 0.25 mg/cm^2 were irradiated with the protons of a Van de Graaff accelerator at 77°K. The increase of electrical resistivity is measured as a function of proton energy between 80 kev and 1.4 Mev. Comparison with theory shows, that the calculated resistivity change is too large by a factor of 2.9, but gives the correct energy dependence. (auth)

910 LOW ENERGY RADIATION DAMAGE TO SURFACES. Hammel, R. L. pp 65-70 of AIAA Fifth Annual Structures and Materials Conference. AIAA Publi-

cation CP-8. New York, American Inst. of Aeronautics and Astronautics, 1964.

The results of initial experiments to determine the synergistic effect produced on selected materials when subjected to a simultaneous exposure to uv and low energy electron radiation in a laboratory vacuum are presented. The materials tested were 304 stainless steel, 5557 soft anodized aluminum, glass, and a white pigmented silicate base paint. All four materials showed consistent changes in absorptance due to the radiation exposures. A slight to moderate increase in absorptance was produced by the uv exposure with the exception of the 5557 anodized Al, which showed no change. Electrons produced a more notable change with all materials. Simultaneous electron-uv exposure in all cases produced the greatest change. (P.C.H.)

911 RECOMBINATION, TRAPPING AND ANNEALING IN 10-50 Mev ELECTRON-IRRADIATED GERMANIUM. Fischer, J. E.; Corelli, J. C. 11p. (CONF-650653–4). Gmelin, AED-CONF-65-170-13.

From American Physical Society, Summer Meeting, New York.

The investigation of the difference in damage between As- and Sb-doped material is extended to higher bombarding energies and the defects found by decay of excess conductivity are correlated to those observed by d-c electrical measurements, namely conductivity and carrier concentration. The experimental arrangement is shown. Excess carriers are introduced by 50 nanosecond pulses of 150 KVP x rays. The two samples are cut from adjacent segments of the same ingot and are irradiated simultaneously at 85°K. The bridge sample is used to monitor d-c conductivity and carrier concentration, using a 950 gauss permanent magnet. The rectangular sample is used for recombination and trapping studies. The samples were warmed to successively higher temperatures in 5–10 degree steps for 15 minutes at each temperature. All measurements were made at 85° unless otherwise noted. Two separate trapping stages were resolved in the decay curves of As-doped samples, whereas the Sb-doped sample exhibits only one stage. This suggests the possibility that one of the trapping stages in the as-doped sample is associated with a low-energy defect, while the other As trap and the one trap in Sb-doped material are characteristic of high-energy bombardment. (J.F.P.)

PHYSICS

General

Refer also to abstracts 504 and 651.

912 (AWRE-O-61/65) A SCALE MODEL INVESTIGATION OF THE FLOW FROM THE OPEN END OF A SHOCK TUBE OF RECTANGULAR CROSS SECTION. Mawbey, M. W. S. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug. 1965. 33p. Dep.; BIS $1.40; HMSO 7s. 0d.

A model investigation of the flow field beyond the mouth of a model open-ended rectangular shock tube was conducted using Schlieren photography and piezo-electric transducers. The movement of the front of this field is determined and comparison is made between the results obtained on a $\frac{1}{14}$th scale and those from the full-scale, 30 in. × 18 in. shock tube. (auth)

913 (LAL-1142) SCATTERING OF 150 AND 300 Mev POSITRONS AND ELECTRONS FROM BISMUTH. Browman, A.; Grossetete, B.; Yount, D. (Laboratoire de l'Accelerateur Lineaire, Univ. de Paris, Orsay (France)). Sept. 1965. 38p. Dep. mn.

Positrons and electrons from the Orsay linear accelerator were scattered from bismuth at 6, 10, 15, and 20° at 300 Mev and at points having similar momentum transfers at 150 Mev. In addition to electron-positron ratios, relative and absolute cross sections were measured and are given for the present experiment as well as for the high- and low-resolution experiments reported earlier. The latter data extend to 45° at 300 Mev ($q^2 \approx 1.4\ f^{-2}$). The combined data from the three experiments are internally consistent and are in general agreement with the partial wave predictions based on earlier electron scattering results. However, the electron-positron ratio in the neighborhood of the 6°, 300 Mev point disagrees by 2.2 standard deviations with the partial wave predictions and also with the value for the ratio obtained at the corresponding 150 Mev point when the latter is scaled to 300 Mev by means of a "model independent" scaling law. The present data thus confirm the discrepancy noted earlier in which the results of Goldemberg, Pine and Yount at 5° and 300 Mev disagreed with the partial wave predictions and with the scaled results of Miller and Robinson taken at energies below 170 Mev. (auth)

914 (NASA-TN-D-2950) MODULATION AND SAMPLING OF HYDROMAGNETIC RADIATION. Sonett, Charles P. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Oct. 1965. 75p. CFSTI $3.00 cy, $0.75 mn.

It is shown that the detection of electromagnetic signals in the hydromagnetic domain by means of magnetometers is a low frequency extension of the electromagnetic spectrum; therefore conventional modulation theory is employable, subject to the special constraint that the carrier frequency is determined by spacecraft motions. In the presence of a hydromagnetic continuum, spacecraft spin modulation folds the spectrum so that fictitious offsets, ambient field errors, and the generation of spurious wave signals can occur, the latter from single sidebanding. Synchronous demodulation by means of time quadrature detectors can be employed to remove such effects. Commutated telemetry which time shares experiments is shown to yield a multirate sample spectrum. Thus telemetry can cause uncorrectable spectral folding of many orders because it generates a complex switching spectrum containing a subsidiary multiplet structure about each of the principal switching tones. (auth)

915 (ORNL-TM-1166) EXPLORATORY EXPERIMENTS CONCERNING THE DESORPTION OF GASES BY BOMBARDMENT WITH ELECTRONS. Clausing, R. E. (Oak Ridge National Lab., Tenn.). Nov. 3, 1965. Contract W-7405-eng-26. 34p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Electron bombardment of metal surfaces was investigated as an aid to the degassing of vacuum systems. The amount of gas released depended on the nature of the surface and the energy of the electrons, but the composition was insensitive to the electron energy. When a surface was bombarded for the first time with electrons of energy greater than 20 kev, a brief period of very efficient desorption occurred; the source of this gas was not renewed during several days without bombardment but with vacuum maintained. Electron bombardment is particularly effective for removing organic contamination from surfaces. Also, it is useful for monitoring thermal degassing. (auth)

916 (SRIA-425-6) SORPTION OF GASES ON METAL SURFACES IN ULTRAHIGH VACUUM. Quarterly Progress Report No. 11, May 15–August 15, 1965. Bergsnov-Hansen, B.; Endow, N.; Evans, B.; Pasternak, R. A. (Stanford Research Inst., Menlo Park, Calif.). Aug. 20, 1965. Contract AT(04-3)-425. 34p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The physisorption of Xe and Kr on glass and a Mo film was studied. The hydrogen–deuterium exchange reaction on a Mo film was investigated. Data on the interaction of oxygen with Nb are discussed. A paper on the sorption of nitrogen and oxygen by Nb at very low pressures, which is included, is abstracted separately. (D.L.C.)

For an abstract of the individual paper see: 775.

917 (TID-22277) TEMPERATURE DEPENDENCE OF THE OPTICAL REFLECTIVITY OF CERIUM METAL. Millhouse, A. H.; Leinhardt, T. E. (Virginia Polytechnic Inst., Blacksburg. Dept. of Physics). Aug. 31, 1965. Contract AT(40-1)-2689. 28p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The optical reflectivity of polished, vacuum-annealed samples of Johnson-Matthey cerium was examined at 300 and 80°K. The specimens were mounted in an evacuated optical cryostat. All measurements were made with monochromatic light incident upon the plane surfaces of the samples at an angle of 45°. The source of the radiation was a modified Bausch & Lomb grating monochromator. Type 1P28 photomultipliers were used as detectors. Results indicate that there is a decrease in the ratio of the reflectivity at 80°K over that at 300°K in the 4000- to 6000-Å region. In one specimen, this amounted to about a 20% change. Below 4000 Å, the ratio increases rapidly as shorter wavelengths are approached. (auth)

918 TIME REVERSAL. Gwynne, Peter. Discovery, 26: 28-32(Oct. 1965).

An experiment is summarized in which a violation of CP invariance and, according to the CPT theorem, of time reversal invariance was observed in the decay of mesons (K_L^0). Some attempts to account for the experimental results are outlined including the existence of a fifth force in nature and invalidity of the CPT theorem. (D.C.W.)

919 APPROXIMATE CALCULATION OF TWT TRANSVERSE ELECTRON OSCILLATIONS WITH DEPENDENCE OF ELECTRON MASS ON VELOCITY. Sovetov, N. M. (Saratov Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zavedenii, Radiofiz., 8: 561-8(1965). (In Russian).

By means of the external field method the approximate system was written of nonlinear differential equations describing the transverse electron displacement in TWT under the action of high-frequency field. The electron trajectories were found from which the beam divergence at different values of parameters was estimated. The approximate formulae were obtained for calculation of the electron beam focusing. (auth)

920 LIGHT INTENSITY AND FREQUENCY INVERSION OF THE JOSHI EFFECT. Venugopalan, M. (Banaras Hindu Univ., Banaras, India). Nuovo Cimento (10), 36: 1121-9(Apr. 16, 1965).

It is shown that the Joshi effect $\pm\Delta i$, an almost instantaneous and reversible photovariation of the discharge current i, in halogens increases with light intensity I more rapidly at low than at large I, where it exhibits a saturation effect, the applied potential V being constant and just below or well above the threshold potential V_m. At or near V_m, $+\Delta i$ increases with I to a maximum, then diminishes, and finally inverts to $-\Delta i$. This inversion as well as the enhancement in $\pm\Delta_i$ with light frequency v is linear; the threshold frequency v_m decreases with V. For a given minimum I and v, $+\Delta i$ inverts to $-\Delta i$ as V is increased progressively above V_m at the inversion potential V_i. This last decreases with I and v. The inversion with I or v occurs in the potential range V_m to V_i. The results agree with the theory that photoemission from an adsorbed layer with a low work function gives $+\Delta i$ per se. $-\Delta i$ is ascribed to a negative space charge produced near the (instantaneous) cathode. A detailed mechanism for the inversion is proposed. (auth)

921 GROUND STATE OF AN ELECTRON GAS IN A MAGNETIC FIELD. Celli, V. (Universita, Bologna); Mermin, N. David. Phys. Rev., 140: A839-53(Nov. 1, 1965).

The ground state of an electron gas in a uniform magnetic field is found to be not the customary uniform state, but rather one in which a spin-density wave exists, directed along the field. This conclusion is reached through what is essentially a Hartree-Fock calculation with a repulsive interaction, but in which no restrictive assumptions are made about either the strength or the range of the exchange interaction. Thus static screening does not eliminate the spin-density wave in the presence of a magnetic field, as it does in the electron gas when no magnetic field is present. The temperature at which the transition to a spin-density-wave state occurs approaches zero as the field vanishes. The pertinent question is therefore not the nature of the ground state, but whether there is a range of field strengths and electronic densities for which the transition temperature is observably high. It is found that spin-density-wave formation is most favorable when only a few Landau levels are occupied, corresponding to large field strengths and low electronic densities. A rough calculation indicates that in InSb a transition temperature as high as 10 millidegrees can be realized. (auth)

922 OUR KNOWLEDGE OF THE FUNDAMENTAL CONSTANTS OF PHYSICS AND CHEMISTRY IN 1965. Cohen, E. Richard (North American Aviation Science Center, Thousand Oaks, Calif.); duMond, Jesse W. M. Rev. Mod. Phys., 37: 537-94(Oct. 1965).

Experimental data bearing on the precision determination of the numerical values of the fundamental physical contants are reviewed, with particular emphasis being placed on the identification and isolation of discrepancies and inconsistencies. The purpose of the analysis is to present a consistent set of values of the fundamental constants and to present a careful and complete description of the steps taken to reach this end. The introduction discusses the significance of such an analysis and indicates the general method of approach. The indispensability of local unit systems and conversion factors connecting them, in order to avoid a sacrifice of precision peculiar to different metrological techniques, is emphasized. The point is stressed that conversion constants introduce the danger of ignoring error-statistical correlations between physically measured quantities, and the effects of such correlations on the assignment of errors is discussed. All available sources of experimental information relative to the necessary input data are presented, and changes in definitions of units since our last review are discussed. After the available stochastic input data have been reviewed and the less reliable items eliminated, the third section examines the remainder for mutual compatibility by means of an analysis of variance in which special criteria for recognizing the incompatibility of a datum are developed, using the analogy of the energy of internal strain introduced in overdetermined mechanical structures. Tables of least-squares adjusted values of fundamental constants and conversion factors of physics and chemistry based on the 1963 adjustment are given. Research pertinent to the constants which was completed or published subsequent to the 1963 "recommended" adjustment is discussed, and the effect of these on knowledge of the numerical values of the fundamental constants is presented. (auth)

923 SYSTEMATIC INVESTIGATION OF THE DIMINUTION COEFFICIENTS OF ELEMENTS OF ATOMIC NUMBER 1 TO 30 WITH RESPECT TO GAMMA AND ROENTGEN RADIATION IN THE ENERGY RANGE 6 TO 85 kev. Weissmantel, Chr.; Wuenschmann, M. (Technische Hochschule, Karl-Marx-Stadt, Ger.). Z. Chem., 5: 191-3(May 1965). (In German).

The following radioactive species were used to measure the absorption of radiation by the first 30 elements: ^{55}Fe, $K\alpha_1$ 5.898 kev; ^{73}As, $K\alpha_1$ 9.885 kev; ^{125}I, $K\alpha_1$ 27.471 kev; ^{170}Tm, $K\alpha_1$ 52.36 kev; and ^{170}Tm, β 84.2 kev. A scintillation counter was used for ^{125}I and ^{170}Tm, and a proportional counter for ^{55}Fe and ^{73}As; a single-channel spectrometer and a 100-channel analyzer were employed. Materials available in solid and liquid states were used; 14 elements and 50 compounds were studied in various forms (foil, pellets, liquids in cuvettes). The diminution coefficient is a summation of the scattering coefficient and the absorption coefficient; the functional relation of scattering coefficient has been studied already. The relation found for the absorption coefficient is exponential; for the 52 kev radiation, $\tau/\rho = C \cdot Z^{3.20\pm0.02}$. The dependence of absorption coefficient on radiation energy was also studied; illustration of data for C, N, and O on double logarithmic plots shows parallel lines. (BBB)

924 ERGEBNISSE DER EXAKTEN NATURWISSENSCHAFTEN. 37. BAND. (Conclusions of Mathematical Sciences. Vol. 37). Hoehler, G. Springer Tracts in Modern Physics. Berlin-New York, Springer-Verlag, 1965. 183p. DM,—; $11.00.

Separate abstracts were prepared for the five papers included. (D.C.W.)

For abstracts of individual papers see: 740, 1060, and 1235—1237.

925 QUANTUM RADIO FREQUENCY PHYSICS. Stepin, L. D. Cambridge, Mass., The M.I.T. Press, 1965. 235p. $6.00.

Translated by Scripta Technica Inc.

The physical concepts and some of the theoretical problems which form the foundation of quantum radio frequency physics are presented. The phenomena of electron and nuclear magnetic resonance and the methods used in their observation are discussed. Attention is given to radio frequency spectroscopy with gases and to the operation of a molecular oscillator using a beam of ammonia molecules. (L.B.S.)

926 DEVELOPMENTS IN THEORETICAL AND APPLIED MECHANICS. VOLUME 1. PROCEEDINGS OF THE FIRST SOUTHEASTERN CONFERENCE HELD AT GATLINBURG, TENNESSEE, MAY 3–4, 1962. New York, Plenum Press, 1963. 537p. $16.00. (CONF-620501).

A broad range of current research in mechanics is discussed under four headings: dynamics and vibrations; solid mechanics; fluid mechanics; and experimental and applied mechanics. Theoretical treatments are primarily emphasized in the first three categories, but with specific application to such problems as analysis of strain in a solid-propellant rocket motor, buckling of plates of various configurations, high speed flow, and problems encountered in supersonic flow past a cone. The section on dynamics and vibrations features several papers on computational methods and mathematical treatments, together with contributions concerning such varied problems as beam vibration, wave propagation studies, and the use of the WKB method in applied mechanics. Discussions on experimental and applied

mechanics include the application of matrix theory to the solution of beam grillage problems, behavior of shells in several configurations, and treatments of a more applied nature: collapse of tubes, failure theories for orthotropic materials, and seismic vibrations of reactor structures. (L.B.S.)

927 HAZARDS OF TRITIUM OXIDES INDUCED IN LARGE HEAVY WATER REACTOR STATIONS. Holmquist, C.-E. 14p. (CONF-650540-6). Gmelin, AED-CONF-65-116-7.

From American Industrial Hygiene Association Meeting, Houston, Tex.

The potential hazards for the environment of tritium oxides released from large heavy water reactors are reviewed. The production of tritium is discussed and the potential hazards of tritium contamination of air or liquids are considered. Strict industrial hygiene measures, routine bioassays, and protective clothing for the protection of personnel are stressed. (C.H.)

Accelerators

Refer also to abstracts 991, 1143, and 1233.

928 (BNL-9500) ALTERNATING-GRADIENT SYNCHROTRON CONVERSION PROGRAM. SCOPE OF PHASE I. (Brookhaven National Lab., Upton, N. Y.). Sept. 1965. Contract AT(30-2)-Gen-16. 191p. Dep. mn; CFSTI $5.00 cy, $1.00 mn.

An overall report on the conversion program of the AGS to increase its beam intensity to about 2×10^{13} protons per second at 30 Bev is presented. The design of the proposed new 500-Mev injector is described in detail. Discussions concerning the new injector include the preinjector, beam transfer from preinjector to linac, choice of linac accelerating structures, the drift tube accelerator, and the accelerator services. The AGS modifications required to achieve high intensity and those modifications required by high intensity are discussed in detail. A summary of costs, manpower, and time schedules is included. (M.O.W.)

929 (BNL-9514) NORMAL MODE ANALYSIS OF STANDING WAVE LINACS. Nishikawa, T. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 15p. (CONF-650923-6). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 5th International Conference on High Energy Accelerators, Frascati, Italy.

Microwave cavity theory is used in a normal-mode analysis of the electric fields in a linac. The generator-excited and beam-induced fields are calculated separately, then added to give the total field with beam loading. (T.F.H.)

930 (BNL-9553) THE CHOICE OF PROFILE PARAMETER k_0 AND MAGNET STEEL FOR AGS MAGNETS. Dahl, P. F.; Parzen, G. (Brookhaven National Lab., Upton, N. Y.). Sept. 16, 1965. Contract AT-30-2-GEN-16. 10p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Further calculations on a modified AGS magnet were made by taking the standard AGS open C-magnet as the point of departure. The consequences of varying the gradient of the pole tip, the B-H curve, and the choice of magnet steel are discussed. The results are summarized. (M.O.W.)

931 (BNL-9554) DISPERSION RELATION AND FREQUENCY CHARACTERISTICS OF THE ALTERNATING PERIODIC STRUCTURE FOR LINEAR ACCELERATORS. Nishikawa, T.; Giordano, S.; Carter, D. (Brookhaven National Lab., Upton, N. Y.). Aug. 23, 1965. Contract AT-30-2-GEN-16. 28p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The dispersion curves for the APS were explained and analyzed by means of the cavity-chain theory with Floquet's theorem. In general, one obtains two passbands separated by a stopband for each degenerate UPS band. In the APS, the coupling between the same type of cells is appreciably responsible for the asymmetry of the two passbands. It was shown that, with the use of either tuners or nose cones, it is possible to join these two passbands, eliminating the stopband. The resulting structure, when operated in the $\pi/2$ mode reduced detuning and beam loading effects. (auth)

932 (BNL-9557) COSMOTRON MAGNETIC FIELD MEASUREMENTS. Alderman, J. C. Jr.; Morgan, G. H. (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 15p. (CONF-650922-15). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 1st International Symposium on Magnet Technology, Stanford, Calif.

A complete remapping of the field of the cosmotron magnet was undertaken. Previous measurements of the field were made as a function of time during a pulse, and are presently not useful because several major changes, which were made since the original construction, affect the rate-of-rise of the field. The new measurements are referred to the integrated voltage of the B-dot windings which encircle all four quadrants, i.e., to an average field. The measurements are semi-automated by a system of solid-state switching logic which records most of the data on paper tape for computer analysis. Measurements of field are made to an accuracy of better than 0.1%, and of gradient, using paired coils interchanged between pulses, to an accuracy of 1%. (auth)

933 (CERN-65-28) A DISTRIBUTED CARRIER MULTIPLEX SYSTEM FOR FLEXIBLE REMOTE CONTROL AND TELEMETRY APPLICATIONS. Sagnell, B. (European Organization for Nuclear Research, Geneva (Switzerland)). Sept. 1, 1965. 17p. Dep. mn.

The CERN multiplex system replaces direct wire connections in remote control and telemetry circuits and provides 400 channels of independent ON/OFF communication between any points on a 3-km-long trunk cable. Three applications of the system are described: magnet current control, target control, and radiation monitoring. The performance, reliability, and convenience of the system during operation for 18 months are described. (D.L.C.)

934 (ISS-65/4) OPTIK 2. UN PROGRAMMA DI CALCOLO DELL'OTTICA DEI CANALI MAGNETICI. (OPTIK 2—A Program for Magnetic Channel Design). Carloni, G.; Fronterotta, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Feb. 1, 1965. 75p. Dep. mn.

A program to aid the design of magnetic channels for high energy particles was developed. The program was prepared for the IBM 7040 computer of the Laboratories of Physics of the Istituto Superiore di Sanità. The program based on the OPTIK program due to T. J. Devlin (UCRL-9727) was improved to meet some specific needs. The computation is done introducing the usual six component vector to represent position, direction, momentum spread and mass of the beam particles. Problems of focusing of the beam may be solved by imposing single or double focusing or parallelism in either plane and finding the corresponding values of quadrupole strength. Slit effects are evaluated through the limitation of the phase space referred to the source. (auth)

935 (ORNL-TM-1298) SHIELDING CALCULATIONS FOR HIGH-ENERGY ACCELERATORS. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Oct. 14, 1965. Contract W-7405-eng-26. 23p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Shields for high-energy accelerators can be designed adequately and at minimum cost only if detailed calculations of the transport of high energy particles through matter are available. Some of the existing calculations are discussed with the view of indicating the areas of uncertainty. The calculation of electron-photon cascade induced in matter by high-energy electrons and data on particle emission from nuclear collisions are discussed. The nuclear cascade in thick shields is considered and numerical results are compared with experimental values. (M.O.W.)

936 (SLAC–41) LASER BEAMS. THE PRODUCTION OF POLARIZED AND MONOCHROMATIC GAMMA RADIATION BY MEANS OF COMPTON SCATTERING AT ELECTRON SYNCHROTRONS AND LINEAR ACCELERATORS. Milburn, Richard H. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Aug. 1964. Contract AT(04-3)-515. 63p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The possibilities of scattering energetic electrons off an intense laser-generated photon beam for production of polarized and monochromatic gamma radiation are discussed. Some potential ways in which this produced laser beam may be used in conjunction with the Cambridge Electron and Stanford Linear Accelerators are discussed. Characteristics of the new laser beam are discussed. (M.O.W.)

937 (SLAC–45) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1–March 31, 1965. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). June 1965. Contracts AT(04-3)-400; AT(04-3)-515. 100p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

Further developments in various aspects of the Two-Mile Accelerator Project are discussed. The specific areas discussed include plant engineering, system engineering and installations, accelerator physics, instrumentation, heavy electronics, mechanical design and fabrication, klystron studies, beam switchyard, and pre-operations research and development. (M.O.W.)

938 (SLAC–46) THE NATURAL COORDINATE SYSTEM FOR STUDYING VECTOR PROBLEMS. Chu, E. L. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). June 1965. Contract AT(04-3)-400. 46p. Dep. mn; CFSTI $3.00 cy, $0.50 mn.

A curvilinear coordinate system is set up which has a curved non-planar vector line for its coordinate axis. This enables a discussion of natural coordinates in an elementary manner. The derivation starts from basic principles and then many relevant formulas including the metric and the Riemann-Christoffel symbols of this coordinate system are developed. (M.O.W.)

939 (UCRL–16364) A NANOSECOND FERRITE-CORE MAGNET SYSTEM FOR BEAM SWITCHING. Gagnon, William L.; Scalise, D. T.; Smith, Bob H. (Lawrence Radiation Lab., Univ. of California, Berkeley). Aug. 24, 1965. Contract W-7405-eng-48. 12p. (CONF-650922-10). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 1st International Symposium on Magnet Technology, Stanford, Calif.

An experimental study of a kicker magnet for the extraction system of a synchrotron is described. The magnet, which uses ferrite as the return yoke, has a gap of 2 in., and a pole tip area of 12 in.^{2}. The maximum field is 2.5 kOe, which is established with a rise time of about 100 nsec. The pulse length for the magnetic field is 4.8 μsec, and the repetition rate is 60 pulses/sec. The magnet is excited from a coaxial, lumped-constant, pulse line. Construction techniques employed and theoretical limitations of this type of system are discussed. (auth)

940 (UCRL-16382) MAGNET DESIGN APPLICATIONS OF THE MAGNETOSTATIC PROGRAM CALLED TRIM. Colonias, John S.; Dorst, Joseph H. (Lawrence Radiation Lab., Univ. of California, Berkeley). Sept. 1, 1965. Contract W-7405-eng-48. 13p. (CONF-650922-14). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 1st International Symposium on Magnet Technology, Stanford, Calif.

Studies are presented of computations of magnetic fields with the magnetostatic program called TRIM. TRIM is used in the design of quadrupole and sextupole magnets. The irregular triangular mesh utilized by this program allows the computation of fields for both symmetric and asymmetric magnets of any shape. The program is so general that it permits any distribution of currents, several kinds of iron in the same magnet, and voids or currents within the iron. The attainable quality of the computed results is evidenced by comparing with measurements at the CERN proton synchrotron magnet and analytical solutions of simple geometries including an ideal quadrupole. Agreement with CERN measured gradients is within 1%, within the limits of the vacuum chamber. (auth)

941 RESONANCE OF PHASE OSCILLATIONS IN A SYNCHROTRON. Kawasaki, Sunao (Tokyo Univ.). Jap. J. Appl. Phys., 4: 677-86(Sept. 1965).

The possibility that accelerated electrons in a synchrotron escape beyond the region of stability in their phase oscillations due to fluctuations of the operating parameters of the machine was investigated. The results predict that the non-linearity of the oscillations has the most important role in this problem, especially in AG machine, and that there are resonances between the oscillations and the fluctuations when the frequency of fluctuations takes a value of 0.6 ~ 0.7 times that of the phase oscillations, as a principal mode with a rather wide frequency spread. The analyses were compared with the results of the experiments in which the external perturbations were imposed on the amplitude of the accelerating r-f voltage in Todai 170-Mev AGS. Their consistency was rather good. (auth)

942 A 35 GIGACYCLE LINEAR BUNCHING ACCELERATOR FOR ELECTRONS [Thesis]. Kunz, William Edward. Urbana, Ill., Univ. of Illinois, 1964. 140p.

A 35 gigacycle linear bunching accelerator with a non-uniform, disk-loaded waveguide as an accelerating structure is described. An accelerator which theoretically requires 75 kilowatts of pulsed 35 Gc microwave power to accelerate a 20 milliampere beam to a velocity of 0.776c was designed and constructed. The attenuation of and the power flow in the nonuniform structure are analyzed. Fabrication techniques for construction of the disk-loaded waveguide are described. The measured output velocity of the electrons is within one percent of the theoretical value. A design for an accelerator which requires 125 kilowatts of pulsed 35 Gc microwave power to produce a 20 milliampere beam with a velocity of 0.9c is presented and shown to be quite feasible. (Dissertation Abstr.)

943 PROCEEDINGS OF THE 3rd NORDIC-DUTCH ACCELERATOR SYMPOSIUM, HANKO, AUGUST 16–23, 1964. Helsinki, Univ. of Helsinki, 1964. 187p. (CONF-640811).

Separate abstracts were prepared for eight of the nine papers included. The remaining paper was previously abstracted for NSA(17: 4109). (D.C.W.)

For abstracts of individual papers see: 1227–1234.

944 STUDIES OF BEAM DEFLECTION FOR A THREE-SECTOR CYCLOTRON [Thesis]. Beal, Jack William. East Lansing, Mich., Michigan State Univ., 1964. 102p.

Computer studies were made of orbits in the deflector of a three-sector cyclotron. Three basic deflector arrangements are considered with various channel field strengths: a continuous electrostatic channel; an electrostatic followed by a magnetic channel; and a single, 45° electrostatic channel. The studies demonstrate the effects of energy and azimuth at which deflection begins on deflector effectiveness and radial and axial focusing of the deflected beam. The beam can be advantageously accelerated through the $\nu_r = 1$ resonance prior to deflection under proper conditions. The results demonstrate that the $\nu_r = 2\nu_z$ coupling resonance can be traversed without excessive instability. (TCO)

945 CYCLOTRON. Mourier, Georges; Pinel Jacques (to CSF Compagnie Generale de Telegraphs sans Fil). German Patent 1,197,995. Aug. 5, 1965. Priority date Jan. 10, 1962, France.

For the acceleration of the ions the cyclotron has — instead of the known semicircular, hollow electrodes — a delay line within the acceleration chamber. The delay line consists of two sets of parallel electrically conducting rods disposed in two planes symmetrical to the middle plane of the acceleration chamber and vertical to the lines of force of the magnetic field. (Gmelin Inst.)

946 GUIDE DEVICE FOR A BEAM OF CHARGED PARTICLES PRODUCED IN AN ACCELERATOR. Pinel, Jacques (to Compagnie General de Telegraphie sans Fil). German Patent 1,199,900. Sept. 2, 1965. Priority date Mar. 3, 1959, France.

The guide device comprises two succeeding magnets having parallel but oppositely directed lines of force, the magnets being operative to bend the particle path in a plane perpendicular to the lines of force. Between the second magnet and the target there is disposed a magnetic lense which focuses the particles independent of their energy on the target. (Gmelin Inst.)

947 LINEAR ACCELERATOR. Haimson, Jacob (to Varian Associates). German Patent 1,199,901. Sept. 2, 1965. Priority date June 29, 1961, United States.

The linear particle accelerator comprises a loaded wave guide. The load at the end of the wave guide consists of a plurality of resonant cavities obtained by subdividing a hollow cylinder by a plurality of irises. The inside of the resonant cavities is coated with a material of high specific electric resistance. (Gmelin Inst.)

948 LINEAR ACCELERATORS OF TANDEM TYPE. Julian, Frederick Arthur; Riviere, Anthony Christopher (to United Kingdom Atomic Energy Authority). U. S. Patent 3,209,269. Sept. 28, 1965. Priority date June 27, 1961, Great Britain.

An electrostatic accelerator is described that has at least four acceleration stages by the first stage of which a well focused particle beam is provided at the negative high voltage terminal. The positive ion source generates the heavy molecular positive ions of a certain desired element and is held at ground potential. In the negatively polarized terminal zone containing a gas target, at least a portion of the molecular ions disintegrate into fragments, which pick up electrons to form negative ions. These negative ions are accelerated beyond the negatively polarized zone. Certain ions of the given element are selected from the accelerated negative ions and further accelerated towards a positively polarized terminal zone containing means for stripping electrons from at least a portion of the selected ions to form positive ions of the given element. These positive ions are then accelerated beyond the positively polarized terminal zone. The two differently charged zones of the accelerator may be within different pressure vessels adapted to be individually held at ground potential. (B.L.M.)

949 ALL-METAL WAVEGUIDE VACUUM GATE VALVE. Skarpaas, K. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,036. Oct. 12, 1965.

A valve for selectively closing off a waveguide section or providing in-line coupling between waveguide sections is described. The device includes flanges movable axially to permit the alternate insertion of a waveguide coupling section or of a vacuum-tight gate valve closure with the foregoing operations being performed in a vacuum-tight enclosure. The device is especially useful for coupling microwave power into a system such as a linear accelerator in which a plurality of power sources are used to allow disconnection of one or more sources for maintenance, etc., without shutting down the accelerator. (AEC)

950 ABSORPTION OF ENERGY BY ROTATING DISCS IN PARTICLE BEAM DEFLECTOR. Burleigh, Richard J.; Peters, Ralph (to U. S. Atomic Energy Commission). U. S. Patent 3,213,379. Oct. 19, 1965.

A beam deflector for extracting ions from a cyclotron or other accelerators is described. The deflector is of the general type in which a pair of spaced long flat electrodes define an ion channel directed gradually away from the final orbit of the accelerator, the outer electrode being negatively charged to draw the ions outwardly. A considerable number of ions strike the leading edge of the inner electrode and the resultant heating has limited the amount of beam which can be extracted. In this invention the leading edge of the inner electrode is formed by a pair of thin discs which rotate to avoid the continual impingement of ions on one portion of the structure thereby allowing an increase in the beam output. (AEC)

Astrophysics and Cosmology

Refer also to abstracts 1036 and 1108.

951 (NP-15517) NEUTRINOS IN SUPERDENSE MATTER. II. MASSLESS NEUTRINOS IN PERFECT FLUID SPHERE. Kuchowicz, Bronislaw (Warsaw Univ. (Poland). Dept. of Radiochemistry). May 1965. 10p. Dep. mn.

The classical movement of massless neutrinos inside an incompressible fluid sphere is investigated. The substantial result is that for certain values of physical parameters the neutrinos do not leave the interior. Preliminary estimations show that this result may apply to neutron stars. (auth)

952 GRAVITATIONAL STABILITY OF UNIFORMLY ROTATING DISKS. Goldreich, P.; Lynden-Bell, D. Mon. Notic. Roy. Astron. Soc., 130: 97-124(1965).

The stability of a stratified self-gravitating rotating medium is discussed. It is found that in all cases pressure effects stabilize short waves while long waves are stabilized by rotation. When $\pi G\bar{\rho}/4\Omega^2$ is greater than a number between 1.8 and 0.7 (depending on the polytropic index), there is an intermediate range of unstable wave-lengths centered at several times the thickness of the sheet. These instabilities would lead to the break-up of the sheet into masses of definite size. This paper serves as an introduction to the following paper on the stability of differentially rotating media and the formation of paper spiral arms. (auth)

953 SPIRAL ARMS AS SHEARED GRAVITATIONAL INSTABILITIES. Goldreich, P.; Lynden-Bell, D. Mon. Notic. Roy. Astron. Soc., 130: 125-58(1965).

Examples of gravitational instability in differentially rotating media are treated. The particular cases dealt with include polytropic, stratified sheets of gas, as well as the infinite homogeneous media. Application of the results is made to the formation of spiral arms in a differentially rotating disk galaxy. Relations are derived which connect the thickness of the galactic disk, its density, and the velocity dispersion perpendicular to the galactic plane with Oort's differential rotation parameters A and B. Requirements of any theory of spiral arms are discussed, and a mathematical treatment of gravitational instability in a sheared rotating stratified medium is given. These results are discussed qualitatively, and a theory of spiral arm formation based on them is proposed. The observational tests and consequences of the theory are given. Finally, a very brief discussion of barred spirals is presented and the many problems left unsolved by the present work are outlined. (auth)

954 A NOTE ON THE BOUNDARY OF CONVECTIVE ZONES IN STARS. Roxburgh, Ian W. (King's Coll., Univ. of London). Mon. Notic. Roy. Astron. Soc., 130: 223-8(1965).

Convective motions overshoot the boundary of convective zones in stellar models, producing an extended convective zone. This overshooting is considered, and the radius of the extended zone is evaluated. The importance of this overshooting for the theory of stellar rotation is discussed. (auth)

955 LINEAR PARTICLE ACCELERATION IN SPHERICAL ELECTROMAGNETIC INTERACTING FIELDS. Schumann, Winfried Otto (Technische Hochschule, Munich). Z. Angew. Physik., 19: 431-7(1965). (In German).

The particle accelerations occurring in spherically flowing fields are reported. The accelerations in the field of an oscillating current element or an oscillating dipole charge is first considered. The acceleration is radial to the oscillating center. An acceleration in the meridian direction also occurs, but it is relatively insignificant. The effects of the field of an oscillating good-conducting sphere on a free-moving particle are then described. In this case the acceleration occurs in the direction of the radius. This case is of practical significance for the oscillating sun which

strongly accelerates corpuscular streams. The acceleration of currents within a concentric charge arrangement where the particles were accelerated parallel to the transmission axis is also discussed. (tr-auth)

956 RADIOGENIC, SPALLOGENIC, AND PRIMORDIAL RARE GASES IN STONE METEORITES. [PART] III. Hintenberger, H.; Koenig, H.; Schultz, L.; Waenke, H. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 20a: 983-8(Aug. 1965). (In German).

The total content as well as the isotopic composition of helium and neon of 36 stone meteorites were determined. Except for meteorites with primordial rare gas content, the radiogenic component of ^{4}He was calculated by subtracting the fourfold amount of ^{3}He from the total ^{4}He in order to allow for the spallation fraction of ^{4}He. From the content of radiogenic ^{4}He the U-Th-He-ages of the investigated meteorites were calculated. From the content of ^{3}He and ^{21}Ne cosmic ray exposure ages were calculated for all meteorites also. With the new data of the 36 stone meteorites, the total number of stone meteorites, of which rare gas measurements were carried out so far, amounts to 70 bronzite-chondrites and 93 hypersthene-chondrites. The earlier indications for marked differences in the distribution of the U-Th-He-ages as well as for the cosmic ray exposure ages between the bronzite-chondrites and the hypersthene-chondrites proved to be undoubtedly correct. During the investigations, Elm Creek was found as one additional bronzite-chondrite with high amounts of primordial rare gases. In two other bronzite-chondrites (Cavour and Dimmit) primordial rare gases were also detected, but in rather small amounts. (auth)

957 THE INTERACTION OF SCALAR GRAVITATIONAL WAVES WITH THE SCHWARZSCHILD METRIC [Thesis]. Hildreth, William Wesley. Princeton, N. J., Princeton Univ., 1964. 140p.

Scalar gravitational waves are investigated in their interaction with the Schwarzschild metric. The boundary condition is imposed that an incident scalar gravitational wave must approach a purely ingoing wave as the Schwarzschild radius is approached from the exterior region. It is found that an incident plane scalar wave is scattered from the Schwarzschild metric, with a cross section, in the long wavelength limit, of $d\sigma_{scat}/d\Omega = 30.7\ B^2$, where B is the Schwarzschild radius in isotropic coordinates. The total absorption cross section is: $\sigma_{abs} = 201\ B^2$. The analysis can be applied to an agglomeration of matter undergoing free gravitational collapse. This type of object, revolving in an elliptical orbit about a companion star, is affected by a fluctuating scaler gravitational field, and scattering and absorption of energy from the scalar field occurs. The fractional variation in G at the earth, due to the scattering of scalar waves from a binary stellar system at a distance of one parsec and with a harmonic at 20.46 minutes is four orders of magnitude below the expected sensitivity of an experiment under development. The possibility that a quasistellar radio source is a massive degenerate body, with a gravitational redshift, at a distance of ~50 kiloparsec, can not be eliminated by the observational data. This possibility, together with a fission model for the core of a quasi-stellar object, yields a binary system which can produce a fractional variation in G, at the earth, of a few parts in 10^{12} per year, only one order of magnitude below the range of detectability of a presently proposed experiment. The interaction between an object undergoing continuous gravitational collapse and the cosmological scalar gravitational field is found to produce unobservably small effects. (Dissertation Abstr.)

958 STRUCTURE AND EVOLUTION OF MODEL HELIUM STARS [Thesis]. Divine, Theodore Neil. Pasadena, Calif., California Inst. of Tech., 1965. 117p.

Numerical models constructed which describe the evolution of stars which are initially pure helium. The iterative technique, programmed for a large computer, permits the inclusion of radiation pressure, electron degeneracy, electron scattering opacity, gravitational contraction, and detailed composition changing brought about by triple-alpha and (α,γ) reactions. The twenty homogeneous (pure helium) models, which range in mass from 0.4 to 60 $M_\odot$, form a main sequence on the left of the H-R diagram. Evolutionary sequences of models at 0.5, 1, and 6 $M_\odot$ exhaust their central helium supply in times of 80, 12, and 0.8 million years. Thereafter the convective core models, which have remained near their main sequence positions, are replaced by shell source models of increasing luminosity. At all three masses the final composition of the helium-exhausted core is almost exclusively oxygen, although a reduced rate for $^{12}C(\alpha,\gamma)^{16}O$ can lead to moderate fractions of carbon. There is no clear indication that the models correspond to any group of observed stars. Massive helium star models may resemble Wolf-Rayet stars in mass, luminosity, and effective temperature. (Dissertation Abstr.)

Atomic Physics

Refer also to abstracts 351, 1331, and 1334.

959 (AD-613546) RESEARCH IN GAMMA-RAY SCATTERING, ABSORPTION, AND ELECTRON POLARIZATION. Final Report. (Pennsylvania Univ., Philadelphia). July 1962. Contract AF49(638)-537. 66p. (AFOSR-3147). CFSTI $3.00 cy, $0.75 mn.

Research on gamma scattering, electron polarization, optical pumping experiments, and preparation and detection of beams of slow polarized electrons during the period Jan. 1959 through June 1961 is summarized. (P.C.H.)

960 (AROD-2810.18) A MODEL FOR ATOMIC EXCITED STATES II EIGENVALUES AND EIGENFUNCTIONS. Technical Report No. 7. McGuire, E. J. (Cornell Univ., Ithaca, N. Y. Dept. of Physics). July 1965. Contract DA-31-124-ARO(D)-43. 33p.

A model for one-electron excited states is described that can be used in calculations of atomic photoabsorption processes in the soft x ray region. (auth)

961 (ORNL-3836, pp 67-73) ATOMIC AND MOLECULAR CROSS SECTIONS. Barnett, C. F.; Ray, J. A. (Oak Ridge National Lab., Tenn.).

The population and existence of highly excited states of H_2 formed from electron capture of H_2^+ in hydrogen gas have been determined. For a 50-kev H_2 particle, the fraction in high quantum states increases monotonically from 6.8×10^3 v/cm to 4×10^4 v/cm. These excited states have been described as a single, high-quantum-orbital electron plus an H_2^+ core with the orbital electron existing in states similar to the high quantum states of hydrogen atoms. Direct-current measuring techniques have been used to determine the response of silicon semiconductor detectors from low-energy protons or neutral hydrogen atoms. A small voltage was applied across the barrier to bias out leakage currents, and the d-c flow arising from particle impact was determined. The gain increased with increasing particle energy, and the average expended energy per electron collected was 4.1 and 3.8 ev/electron for H^+ and H_3^+ respectively. Detection of low-energy protons with silicon-barrier detectors using conventional pulse-height analysis has been extended to the 7-kev range. Vacuum-tube preamps arranged from mimimum input capacitance resulted in a full width at half maximum amplitude of 6.5 kev with 15-kev protons. Replacing the preamp with a field-effect transistor preamp mounted in the vacuum system and cooled with liquid nitrogen decreased the resolution to 3.35 kev for 7.2-kev protons. Barium titanate crystals have been used as a pyroelectric detector for low-energy protons. Minimum detectable power was 10^{-4} w/cm^2, corresponding to polarization currents of 10^{-12} amp. Integral energy loss of protons passing through 600-A aluminum foils has been determined by measuring the d-c gain of a silicon semiconductor detector with and without the foil placed in front of the detector. Results obtained for 10- to 30-kev protons are a factor of 203 greater than those obtained by more conventional techniques. (auth)

962 (ORNL-3836, pp 74-80) HIGH-CURRENT ION-BEAM PRODUCTION AND INJECTION. Davis, R. C.; Hall, R. R.; Kelley, G. G.; Morgan, O. B.; Stratton, R. F. (Oak Ridge National Lab., Tenn.).

The development is reported of a 100-kv test stand for the production of intense hydrogen-ion beams in the energy range 20 to 100 kev. Total hydrogen-ion beams of 900 ma can be produced at energies of 70 kev. Well-collimated H^+ beams up to 450 ma can be produced at energies of 60 kev. Attempts to produce intense H_2^+ beams have been limited to only 150 ma from a total hydrogen beam of 300 ma. (auth)

963 (TID-22313) THERMAL DIFFUSION IN GASES. Final Report, September 1, 1956-August 31, 1965. Mason, Edward A. (Institute for Molecular Physics, Univ. of Maryland, College Park). Sept. 30, 1965. Contract AT (40-1)-2058. 12p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The study of thermal diffusion and diffusion in binary gas mixtures at pressures of the order of an atmosphere is especially suitable for obtaining experimental information on the forces between unlike molecules. A brief summary is presented of the research program on thermal diffusion in gases and gas mixtures. (D.L.C.)

964 ON SINGULARITIES IN EIGENFUNCTIONS. Lakin, W. (New York Univ., N. Y.). J. Chem. Phys., 43: 2954-8(Nov. 1, 1965).

The relation between some singularities of the eigenfunction and convergence of the Legendre expansion was studied for the ground state of the helium atom. (auth)

965 NITRIDE AND OXIDE BANDS OF MOLYBDENUM. Howard, John C.; Conway, John G. (Univ. of California, Berkeley and Livermore). J. Chem. Phys., 43: 3055-7(Nov. 1, 1965). (UCRL-14139).

Investigation of the orange system bands (5990-6300 Å) produced by a molybdenum arc in air showed that they are a nitride system, and not an oxide as previously reported. Isotope shifts using nitrogen-14 and -15 are given. Evidence is presented that other bands, less conspicuous and hitherto unidentified, occurring in the red are an oxide of molybdenum, together with confirmation that the near-infrared bands formerly attributed to an oxide are such. (auth)

966 COLLISION DENSITY OF HOT ATOMS. Felder, R. M.; Kostin, M. D. (Princeton Univ., N. J.). J. Chem. Phys., 43: 3082-6(Nov. 1, 1965).

The energy-dependent collision density of hot atoms is discussed and evaluated for several cases. A model is considered in which hot atoms collide with a single species of thermal atoms at energies where the asymptotic solutions of the Boltzmann equation are valid. Elastic nonreactive collisions between unlike species are treated in detail. It is shown that the assumption that the collision density is given by $1/E\alpha(E)$, where α is the mean logarithmic energy decrement of the hot atoms, is generally reasonable, but that error may be introduced if the energy dependence of α is not explicitly taken into account. Results are obtained for a class of interaction potentials which includes the inverse power potential, $V = K/r^s$. The degree of scattering anisotropy is directly related to the exponent s of this potential: $s = \infty$ corresponds to isotropic (hard-sphere) scattering, and $s = 1$ represents the limiting anisotropic case of pure Coulombic scattering. A quantitative estimate of the influence of anisotropy on the collision density is thus provided by the results obtained. An example is then given to illustrate the application of the techniques shown to system in which reactions occur. (auth)

967 AN APPROACH TO SCREENING FOR COULOMB WAVE FUNCTIONS. Lewis, H. R. Jr. (Princeton Univ., N. J.). J. Math. Anal. Appl., 11: 338-49(July 1965). (PUC-1963-112).

A possible method for generalizing analytic representations of Coulomb wave functions to include screening is described. One-dimensional integral representations for the Coulomb problem are replaced with two-dimensional integral representations which include the screening function in the kernel. The equations for a two-dimensional representation with exponential screening are presented. A formal solution of the equations is obtained for the nonrelativistic case. (auth)

968 TOTAL CROSS SECTIONS OF THE PHOTOELECTRIC EFFECT FOR URANIUM. Rakavy, G.; Ron, A. (Hebrew Univ., Jerusalem). Phys. Lett., 19: 207-8 (Oct. 15, 1965).

The results are presented of calculations of total photoelectric cross sections for uranium in the energy range from 0.01 to 2.00 Mev. In the calculations, both the bound and free wave functions were numerical solutions of the Dirac equation with the Thomas-Fermi potential. (D.C.W.)

969 MEASUREMENTS OF THE ENERGY DISTRIBUTION OF CHARGED PARTICLES AFTER PASSAGE THROUGH A THIN FOIL. Ophel, T. R.; Morris, J. M. (Australian National Univ., Canberra). Phys. Lett., 19: 245-7(Oct. 15, 1965).

The energy distribution of protons after passage through a carbon foil was measured. The measured distribution was compared with the distribution calculated by the Symon theory. Reasonable agreement was obtained except in the low-energy region where the observed intensity was considerably larger than predicted. (D.C.W.)

970 ANGULAR DISTRIBUTIONS FOR e^--H SCATTERING NEAR THE FIRST INELASTIC THRESHOLD. Scott, Bruce L. (Univ. of Southern California, Los Angeles; Thompson Ramo Wooldridge Inc., Redondo Beach, Calif.). Phys. Rev., 140: A699-704(Nov. 1, 1965).

Differential cross sections for e^--H scattering are presented for several energies above the first inelastic threshold for the $1s \rightarrow 1s$, $1s \rightarrow 2s$, $1s \rightarrow 2p$, and $2s \rightarrow 2s$ transitions. The calculations are based on R matrix elements computed in the 1s-2s-2p close-coupling approximation supplemented by Born-approximation values for the higher angular-momentum states. (auth)

971 MEASUREMENTS OF RESONANT ELECTRON CAPTURE IN CLOSE H^+-ON-H COLLISIONS. Helbig, Herbert F.; Everhart, Edgar (Univ. of Connecticut, Storrs). Phys. Rev., 140: A715-20(Nov. 1, 1965).

Differential measurements of the electron capture probability P_0 are made for protons scattered from atomic hydrogen targets. The incident proton energy ranges from 150 kev down to 0.130 kev and the scattering angle is varied between 0.2 and 6.0°. Seven sharply resonant peaks of P_0 are found, their location depending on both energy and angle. For example, when the scattering angle is held at 6° the peaks are found at 21, 3.9, 1.7, 0.90, 0.54, 0.36, and 0.19 kev, and when the energy is fixed at 0.250 kev, peaks are found at 0.7, 1.4, 2.6, and 4.5°. In some cases the equivalent collision with deuterium, D^+-D, is used to augment the range of the measurements. These data extend those reported by Lockwood and Everhart (1962) who studied this same phenomenon in H^+-H collisions over a smaller range in energy and at fixed 3° scattering angle. Relative differential-cross-section data are presented also which show a change in slope with the onset of rainbow-angle scattering conditions. (auth)

972 QUANTUM- AND CORRELATION-CORRECTED THOMAS-FERMI-DIRAC EQUATION. Barnes, John F. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 140: A721-6(Nov. 1, 1965). (LA-DC-6676).

Use is made of a previously obtained "quantum correction" to the statistical model of the atom, and of a very simple approximation to the correlation energy, in deriving a quantum- and correlation-corrected Thomas-Fermi-Dirac (TFD) equation. One expects the radial density distribution and potential calculated from this equation to be improved over those on the TFD model, both near the nucleus and near the outer boundary of the atom or ion. Minimum-energy (zero boundary pressure) solutions for rare-gas atoms are found to possess values of cell radius in good agreement with those calculated from experimental values of the lattice parameter. (auth)

973 THEORY OF LOW-ENERGY-ELECTRON SCATTERING BY POLAR MOLECULES. Mittleman, M. H.; von Holdt, R. E. (Univ. of California, Livermore). Phys. Rev., 140: A726-9(Nov. 1, 1965). (UCRL–14187).

The diffusion cross section for electrons in a gas of polar molecules is calculated. The improvement over a previous calculation is the use of the exact scattering cross section of a charged particle by a point dipole rather than the first Born approximation. For H_2O the correction amounts to about 20% and worsens the agreement with experiment. (auth)

974 ELECTRON CAPTURE BY HIGH-ENERGY DEUTERONS IN GASES. Berkner, Klaus H.; Kaplan, Selig N.; Paulikas, George A.; Pyle, Robert V. (Univ. of California, Berkeley). Phys. Rev., 140: A729-31(Nov. 1, 1965). (UCRL–16054).

Measurements of electron-capture cross sections of 12.9- and 21.0-Mev deuterons in He, N_2, and Ar are reported and compared with published theoretical estimates and experimental results for protons with energies ≤1 Mev. (auth)

975 OPTIMAL VARIATIONAL METHOD FOR PAIR CORRELATIONS IN MANY-FERMION SYSTEMS. Porter, James C. (Univ. of Michigan, Ann Arbor). Phys. Rev., 140: A732-47(Nov. 1, 1965).

By means of a suitably chosen variational principle, Euler equations are derived which generalize the Hartree-Fock equations in such a way as to include two-particle correlations. For a system of N fermions these equations involve N single-particle functions and $\frac{1}{2}N(N-1)$ pair correlation functions. The Euler equations are optimal in the sense that a more accurate estimation of the total energy would require the introduction of three-particle correlation functions and the retention of terms nonlinear in the two-particle functions. Although intended primarily for use in the calculation of atomic and molecular electronic structure, the Euler equations are here used to determine the Coulomb correlation energy in the case of the high-density electron gas. The result obtained is shown to have the same leading logarithmic divergence with density as that found previously by Gell-Mann and Brueckner. (auth)

976 MODIFICATIONS OF THE IMPULSE APPROXIMATION FOR IONIZATION AND DETACHMENT CROSS SECTIONS. Robinson, Bruce B. (RCA Labs., Princeton, N. J.). Phys. Rev., 140: A764-8(Nov. 1, 1965).

A bound-state correction is suggested for the Thomson-Gryzinski impulse approximation. Also, it is noted that Slater's rules yield estimates of kinetic-energy expectation values which are more accurate than those used in previous applications of this approximation. These corrections are important for neutral atoms with outer electrons in a p state and for all negative ions. Comparison is made with experiment and previous theoretical results. (auth)

977 DIFFERENTIAL ANGULAR DISTRIBUTION OF H AND H^+ DISSOCIATION FRAGMENTS OF FAST H_2^+ IONS INCIDENT ON H_2 GAS. McClure, G. W. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 140: A769-78(Nov. 1, 1965).

Angular distributions of the fast H and H^+ dissociation fragments produced in single collisions of H_2^+ with H_2 have been measured in the energy range 5 to 80 kev. The observed distributions are discussed in terms of three dissociation reactions, $H_2^+ \rightarrow H^+ + H$, $H_2^+ \rightarrow H^+ + H^+ + e$, and $H_2^+ + e \rightarrow H + H$, whose relative proportions vary strongly over the energy range of the investigation. Distributions of the component of velocity of the dissociation fragments transverse to the H_2^+ beam direction are deduced from the measurements. The H-atom transverse velocity distributions are approximately independent of H_2^+ projectile energy and are dominated by H atoms from the H + H dissociation reaction. The H^+ transverse velocity distributions vary in width as the H_2^+ ion energy is varied. At low energies, where the H^+ production is dominated by the $H^+ + H$ reaction, the transverse velocity spread is narrower than at high energies where the $H^+ + H^+ + e$ reaction dominates the H^+ production. A theory of the dissociation mechanism which predicts the angular distribution of dissociation fragments is developed. The theory is based upon Born-approximation calculations of the dissociation cross section versus internuclear axis orientation and internuclear spacing of the H_2^+ ions prior to the collision. These calculations, presently available only for the case of an H-atom target and for the $1s\sigma_g \rightarrow 2p\sigma_u$ dissociative transition of the incident H_2^+ ion, were used to deduce the angular distribution of dissociation fragments in the laboratory coordinate system. Fairly comprehensive agreement is found between the calculated distribution and the observed H^+ distribution for an H_2 target at 10 kev where the $H + H^+$ dissociation mode dominates the H^+ production. The theoretical model is used to discuss qualitatively the observed shapes and widths of the H^+ and H transverse velocity distributions and to relate qualitatively the shapes of these distributions to the distribution of H_2^+ ion internuclear spacings prior to the collision. (auth)

978 INCOHERENT SCATTERING OF GAMMA RAYS BY K-SHELL ELECTRONS. Shimizu, Sakae; Nakayama, Yasuyuki; Mukoyama, Takeshi (Kyoto Univ.). Phys. Rev., 140: A806-15(Nov. 1, 1965).

The differential cross section for the incoherent scattering of 662-kev gamma rays by the K-shell electrons of tin, tantalum, and lead was determined by experiment. The scattered photons were selected in coincidence with accompanying K x rays from the scatterer foil, using the NaI(Tl) scintillation detectors and the slow-fast coincidence method. The cross section $d\sigma_K/d\Omega$ was compared with that predicted by the Klein-Nishina formula, $d\sigma_F/d\Omega$, at scattering angles 20°, 35°, 50°, 65°, and 100°. The experimental results show that for all cases with these scatterer elements the cross-section ratio $d\sigma_K/d\sigma_F$ is less than unity for small scattering angles and approaches zero as the angle decreases to zero, as predicted by nonrelativistic calculation. For large angles, this ratio is greater than unity and at 100° it is found to be equal to about 1.2 for tin, 1.3 for tantalum, and 1.5 for lead. The experimental approximate dependence of the cross-section ratio on the binding energy of the struck K-shell electrons was also obtained for various gamma-ray scattering angles. On the basis of certain assumptions an attempt was made to calculate theoretical values to be compared with the experimental results for small and large scattering angles. The calculated values indicate the general behavior of the dependence of the ratio on the scattering angle. (auth)

979 CHERENKOV RADIATION IN INHOMOGENEOUS PERIODIC MEDIA. Casey, K. F.; Yeh, C.; Kaprielian, Z. A. (Univ. of Southern California, Los Angeles). Phys. Rev., 140: B768-75(Nov. 8, 1965).

The formal exact solution to the problem of the radiation of a charged particle traveling with a constant velocity in a periodically inhomogeneous medium is obtained. As a specific example, the case with a sinusoidally varying dielectric profile is treated in detail. Results of the computation are summarized in two graphs from which information concerning threshold velocity for a particular mode, the emission angles for various radiating modes, and the cutoff frequency for a certain mode can be found. Unlike the case of Cherenkov radiation in a homogeneous medium, there exist radiating modes in this inhomogeneous-dielectric case even when the velocity of the charged particle is below the threshold Cherenkov velocity. A formal expression for the radiation spectrum is also given. Approximate expressions for the radiated fields and for the radiation spectrum are obtained when the variation of the permittivity is small. Results are discussed and interpreted. (auth)

980 π-MESON ABSORPTION PROCESSES IN HYDROGENEOUS MATERIAL. Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 2: 223-31(Aug. 1965). (In Russian).

A theoretical analysis is performed of the absorption of slow π^--mesons by bound hydrogen nuclei, a process which has recently been extensively investigated experimentally.

A scheme is suggested for the processes, making it possible to understand all the features of these processes from a unified point of view and describe them semiphenomenologically. (auth)

981 MEASUREMENT OF THE CROSS SECTION FOR ELASTIC ELECTRON SCATTERING IN POLYCRYSTALLINE Al LAYERS AT DIFFERENT TEMPERATURES. Horstmann, M. (Univ., Hamburg). Z. Phys., 188: 124-38(1965). (In German).

Absolute intensities of electrons scattered elastically in a polycrystalline aluminum foil were measured by means of a retarding field apparatus at 51 kev and in the temperature range 150 - 800°K. From the integrated intensities of the Debye-Scherrer rings (I_R), of the temperature diffuse scattering (I_{TDS}) and of the temperature-independent diffuse scattering (I_{DS}), the total cross sections σ of the foil for the corresponding scattering processes were determined. The measured values $\sigma_R(T)$ for Laue-Bragg scattering show very good agreement with the calculation, based on the dynamical two-beam approximation, and $\sigma_{TDS}(T)$ for the temperature diffuse scattering agrees fairly well with the kinematical value for the Einstein model of the vibrating crystal. The temperature-independent part of the elastic background intensity is mainly due to elastic scattering of electrons in the amorphous oxide layer of the aluminum foil. It turns out, that the sum of all cross sections for the elastic scattering processes mentioned increases slightly with temperature. (auth)

982 PRODUCTION OF METASTABLE 2S HYDROGEN ATOMS IN PROTON RARE GAS COLLISIONS [Thesis]. Jaecks, Duane Harvey. Seattle, Univ. of Washington, 1964. 64p.

Cross sections for the production of metastable $2S^1/_2$ hydrogen atoms for the reactions H^+ + He, Ne, Ar, and Xe were measured in the H^+ energy range of 1 to 23 kev, by measuring the Lyman alpha radiation resulting from the reactions in the absence and presence of an electric field The value Q(2S)/Q(2P) was determined for each reaction, where Q(2S) and Q(2P) are the charge transfer cross sections to the $2S^1/_2$ and 2P states of hydrogen. Q(2P) was measured previously; therefore Q(2S) could be determined. Q(2S) was generally found to have two maxima in the energy range investigated, except in the case of helium where no maximum was resolved in Q(2S). No low energy maximum was resolved in Q(2S) for the case of H^+ + Xe. The position and relative magnitudes of the maxima in Q(2S) and Q(2P) are discussed in terms of possible mechanisms involved in charge transfer. (TCO)

Cosmic Radiation

See also Elementary Particles and Radiations
Nuclear Properties and Reactions

Refer also to abstract 1108.

983 (COO-818-59) COSMIC RAY PRIMARY ELECTRON FLUX MEASUREMENT WITH RIGIDITY ABOVE 5 BV [Thesis]. Smith, Lawrence H. (Case Inst. of Tech., Cleveland, Ohio). 1965. Contract AT(11-1)-818. 126p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

A measurement of the cosmic ray flux of electrons and protons is made, using a spark chamber to detect their interactions. The fraction of interactions due to electrons was determined by utilizing the difference between the electron cascade length and the nuclear particle interaction length. The number of nuclear particle interactions per plate was determined by interactions in the lower four lead plates. This information was extrapolated to the upper three plates and subtracted from the number of interactions in them. Two flights were made at different altitudes, 2.16 and 4.35 gm/cm^2. The lower flight, 69P, was made on Sept. 17, 1964, from Palestine, Texas, magnetic rigidity 4.7 BV. The second flight, 78P, was made on Oct. 10, 1964, from the same location. Triggering of the spark chamber is affected by a pair of scintillation detectors in coincidence, the area, solid angle factor being 5.7 sr/cm^2, maximum. This detector system was monitored throughout the flight by observing the non-interacting nuclear particles. These also provided a measurement of the nuclear particle flux, 550 ± 50/sr/m^2/sec. The electron flux was determined at 2.16 gm/cm^2 to be 6.5 ± 3.2/sr/m^2/sec giving a ratio of 1.3 ± 0.62% for the electron/proton ratio. The lower flight, 69P, accumulated more events and provides a better determination of the electron flux, 10.3 ± 2.8/sr/m^2/sec. This gives a ratio of 2.04 ± 0.8% electrons/protons. Using these two flights, the primary flux of electrons was determined to be less than 6.0/sr/m^2/sec, and the primary electron/proton ratio is less than 1.3%. (auth)

984 (IAE-574) UGLOVYE RASPREDELENIYA VTORICHNYKH CHASTITS V YADERNYKH VZAIMODEISTVIYAKH VYSOKOI ENERGII (DISSERTATSIYA). (Angular Distribution of Secondary Particles in High-Energy Nuclear Interaction (Thesis)). Mishakova, A. P. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1964. 164p. Dep. mn.

Multiple production of secondary particles by high-energy cosmic rays (10^{10} to 10^{13} ev) and by 9-Bev accelerated protons was studied experimentally. Angular distributions of shower particles were studied by emulsion chambers in the stratosphere and in a synchrophasotron beam. Angular distributions in the cms, statistical fluctuations of the angular distribution, azimuthal angular distributions, and pair angular correlations were analyzed. (M.J.T.)

985 COSMIC X-RAYS AND GAMMA RAYS. Friedman, Herbert Astronaut. Aeronaut., 3: 8-12(Oct. 1965).

A brief survey on gamma- and x-ray astronomy is presented. Possible processes by which cosmic gamma rays and x rays may be produced are covered, together with experimental programs and instrumentation. (D.C.W.)

986 THE FLUX OF PRIMARY COSMIC RAY ALPHA PARTICLES NEAR GEOMAGNETIC EQUATOR. Puri, R. K. (Indian Inst. of Tech., New Delhi). Indian J. Pure Appl. Phys., 3: 360-2(Sept. 1965).

The flux of the alpha component of primary cosmic radiation was determined at the top of the atmosphere using a nuclear emulsion stack exposed at a station (Hyderabad) near the geomagnetic equator (geomag. lat., 8°N.) in April 1963. The value for alpha flux was found to be equal to (15.7 ± 2.6) particles m.$^{-2}$ ster.$^{-1}$ sec.$^{-1}$. (auth)

987 HUNTING THE NEUTRINO DEEP UNDERGROUND. Wolfendale, A. W. (Univ. of Durham, N. C.). New Scientist, 27: 760-2(Sept. 23, 1965).

International experiments in the gold mines of India and South Africa, which have given the first evidence of neutrinos in the cosmic rays are described. One result in India might also give evidence for a key hypothetical particle long sought by nuclear physicists — the so-called intermediate boson. (auth)

988 THE ATMOSPHERIC NEUTRON SPECTRUM AT HIGH ALTITUDES [Thesis]. Sydor, Michael. Albuquerque, N. Mex., Univ. of New Mexico, 1965. 178p.

A measurement of neutron flux in the range 30 to 130 Mev at altitudes of 10,670 and 100,000 feet was performed with a directionally sensitive proton recoil scintillation detector. Energy calibration was performed with charged cosmic ray particles; efficiency and angular sensitivity were calculated. Four balloon flights to 100,000 feet were undertaken. The angular distribution at balloon altitude showed a maximum at approximately 90° with respect to the zenith in contrast to the downward flux observed at 10,670 feet. The data were consistent with an energy spectrum behaving as $1/E^{1.3}$ with omnidirectional intensity at 100,000 feet of 1.2 10^{-2}/cm^2-sec-Mev over the energy range detected. The directly observed recoil angular dependence and energy spectra were converted to the corresponding functions for incident neutrons by folding in calculated response functions for the detector. (TCO)

Direct Energy Conversion

Refer also to abstracts 723 and 1437.

989 THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE AUXILIARY DISCHARGE TYPE CONVERTER [Thesis]. Walsh, Edward Mary. Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 147p.

Results of a theoretical analysis and an experimental investigation of an auxiliary discharge thermionic energy conversion system operating in the Gabor mode are presented. A system model is developed taking into account electron return to the emitter, volume recombination, ambipolar diffusion, slow ion recapture at the collector, and slow ion reflection at both the emitter and collector. A critical equation is developed, which must be satisfied under equilibrium operating conditions. The parameters of the equation are expressed in terms of measurable plasma and system characteristics. An inverted auxiliary discharge thermionic energy converter was designed, fabricated, and tested. A planar geometry was used, making variation of the interelectrode spacing possible. The characteristics of the system were determined while operating in the Gabor mode. It was possible to determine the values of the parameters of the critical equation from the experimental results and solve for the slow ion reflection coefficient. The value of 0.75 obtained indicates that there is a relatively high probability of slow ion reflection and that all ions are not immediately neutralized at the emitter, serving to verify the concept of slow ion reflection as proposed by Gabor. (Dissertation Abstr.)

Elementary Particles and Radiations

See also Field Theory, Scattering Theory, and Symmetries

Refer also to abstracts 936, 984, 1241, and 1468.

990 (BNL-9490) A HIGH FIELD SUPERCONDUCTING SOLENOID FOR MAGNETIC MOMENT MEASUREMENTS ON SHORT-LIVED PARTICLES. Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 11p. (CONF-650922-12). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 1st International Symposium on Magnet Technology, Stanford, Calif.

The design, field stabilization, performance, and cooling systems for a superconducting solenoid, which is intended for use in the measurement of the Ξ^- magnetic moment, are described. (T.F.H.)

991 (CEAL-1023) SEMI-ANNUAL REPORT FOR THE PERIOD, JANUARY 1-JUNE 30, 1965. (Cambridge Electron Accelerator, Mass.). Sept. 22, 1965. Contract AT(30-1)-2076. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Brief summaries of 34 experiments underway from January through June 1965 are presented. Improvements made in the 6-Bev Cambridge Electron Accelerator and its associated facilities are listed. Other general developments concerning the accelerator are briefly discussed. (M.O.W.)

992 (COO-818-65) A NEW MEASUREMENT OF THE REACTION $\bar{\nu}_e + p \rightarrow \beta^+ + n$. Reines, F.; Nezrick, F. A. (Case Inst. of Tech., Cleveland, Ohio). Jan. 20, 1965. Contract AT(11-1)-818. 7p. (CONF-650111-8). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From CERN Informal Neutrino Conference, Geneva.

The reaction $\bar{\nu}_e + p \rightarrow \beta^+ + n$ was studied with extremely small equipment. The measured positron spectrum is presented. This was used to deduce by phase space and conservation arguments the antineutrino spectrum from fission. The results are presented. (M.O.W.)

993 (COO-818-70) MEASURING THE CROSS-SECTIONS FOR THE REACTIONS $\nu_e + p \rightarrow n + \beta^+$ AND $\nu_e + D \rightarrow 2n + \beta^+$. Jenkins, T. L.; Reines, F. (Case Inst. of Tech., Cleveland, Ohio). Jan. 20, 1965. Contract AT (11-1)-818. 2p. (CONF-650111-9). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From CERN Informal Neutrino Conference, Geneva.

The description of a large liquid scintillator for measuring the cross sections for the reactions $\bar{\nu}_e + p \rightarrow n + \beta^+$ and $\bar{\nu}_e + D \rightarrow 2n + \beta^+$ is given. A discussion of the experiment is included. (M.O.W.)

994 (JINR-P-2332) PLANIROVANIE EKSPERIMENTOV PO n-p-RASSEYANIYU DLYA OPREDELENIYA NAIBOLEE VEROYATNOGO NABORA FAZOVYKH SDVIGOV. (Planning of n-p Scattering Experiments for Determining the Most Probable Set of Phase Shifts). Lehar, F.; Fedorov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 13p. Dep. mn.

The optimal experiment is planned to distinguish between three sets of phase shifts in n-p scattering at 630 Mev. (auth)

995 (JINR-P-2337) REZONANS Y_1^* V SAMOSOGLASOVANNOI MODELI I NARUSHENIE UNITARNOI SIMMETRII. (Resonance Y_1^* From Self-Consistency and Broken Unitary Symmetry). Sventski, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 6p. Dep. mn.

The resonance Y_1^* from a self-consistent model in the three-channel case is discussed. The forces due to the exchange of particles N, Λ, Σ as well as the resonance Y_1^* are taken into account. The unknown coupling constants of stable baryons are related under the SU(3) symmetry, the experimental values for particle masses being taken. There remains only the dependence on the mixing parameter F/D-f. For $f \gtrsim 0.425$ a self-consistency solution was obtained which is in good agreement with experiment. The obtained coupling constants of the resonance almost coincide with SU(3) results which confirms the hypothesis concerning the broken unitary symmetry for particle masses. (auth)

996 (NP-15204) NEKOTORYE VOPROSY TEORII POLYARIZATSIONNYKH YAVLENII V KVANTOVOI ELEKTRODINAMIKE (DISSERTATSIYA). (Some Questions on the Theory of Polarization Phenomena in Quantum Electrodynamics (thesis)). Kresnin, A. A. (Akademiya Nauk Ukrainsokoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1963. 125p. Dep. mn.

Formalisms are presented for the calculation of polarization effects, including the relativistic density matrix of the electron (or positron) and the density matrix and Stokes parameters for photon polarization properties. Calculations are carried out in second-order perturbation theory on the scattering of nonpolarized and polarized electron (positron) beams by polarized electron targets. Discussions are given of bremsstrahlung of polarized electrons, the effect of the proton recoil on the bremsstrahlung polarization, and the change of electron polarization during bremsstrahlung production. Questions of polarization phenomena in electron scattering on finite dimensional nuclei are considered. Expressions are obtained for the scattering cross section of polarized electrons on a nucleus with finite radius with given charge density and for the resulting azimuthal asymmetry, and the electron polarization after scattering is studied. (M.J.T.)

997 (ORNL-P-1607) N-D SCATTERING—VECTOR POLARIZATION OF RECOIL DEUTERONS FROM POLARIZED NEUTRON BEAM. Willard, H. B.; Thornton, S. T.; Jones, C. M. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 5p. (CONF-650928-5). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Conference on Polarization Phenomena of Nucleons, Karlsruhe, Ger.

A beam of polarized neutrons was scattered by an unpolarized deuterium target. The polarizations resulting were calculated by the general tensor moment technique of Simon and Welton. (M.O.W.)

998 (TID-22255) PRELIMINARY RESULTS OF AN EXPERIMENT ON THE POSITRON g FACTOR [Thesis]. Rich, Arthur (Michigan Univ., Ann Arbor. Dept. of Physics). Aug. 1965. Contract AT(11-1)-1112. 92p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The experimental aspects of the positron g factor measurement, which differ from a previous experiment, are discussed in detail. The experimental techniques and apparatus are discussed in detail. Results are presented and discussed. (M.O.W.)

999 NEUTRINO PHYSICS. Lindhout, A. H. Atoomenergie Haar Toepassingen, 7: 125-9(June 1965). (In Dutch).

After a brief description of the neutrino, the experiments carried out to verify the 2-neutrino hypothesis are described. The problems (principally concerned with weak interactions) that can be studied using neutron experiments were discussed. (tr-auth)

1000 SOME QUESTIONS OF THE THEORY OF TWO-PHOTON PROCESSES. Gurevich, G. L.; Khrononulo, Yu. G. (Gor'kii State Univ., USSR). Izv. Vyssh. Ucheb. Zavedenii, Radiofiz., 8: 493-503(1965). (In Russian).

The processes were considered of combinational and double radiation of the matter placed in a resonator with natural frequencies ω_1 and ω_2. Under certain conditions even in the absence of noncoherent pumping anti-Stokes process is shown to occur in the case when the second operating level is metastable. In such a system the excitation of Stokes' process takes place only in the definite interval of amplitude values of the external field. If $\omega_1 + \omega_2 \simeq \omega_{21}$ when ω_{21} is the difference of the operating terms of the matter, in the system there may exist the stationary radiation of the fields of both the frequencies ω_1 and ω_2, noncoherent pumping being sufficiently strong. The stability conditions of such a regime were found. (auth)

1001 ELECTROMAGNETIC WAVE RADIATION BY ELECTRON BEAM MOVING IN A RING WAVEGUIDE. Tretyakova, S. S.; Tretyakov, O. A.; Shestopalov, V. P. (Khar'kov Inst. of Mining, Equipment, Automation, and Computing Techniques). Izv. Vyssh. Ucheb. Zavedenii, Radiofiz., 8: 552-60(1965). (In Russian).

A strict solution was obtained of the problem of electromagnetic wave radiation of the hollow monovelocity electron beam moving in a ring waveguide. The conditions are stated under which the radiation may arise. The Pointing's vector distributions are given in the explicit form for a particular case. (auth)

1002 THE STUDY OF LIFETIMES OF POSITRONIUM IN POLYETHYLENE IRRADIATED BY GAMMA RAYS. Chandra, G.; Kulkarni, V. G.; Lagu, R. G.; Thosar, B. V. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 19: 201(Oct. 15, 1965).

The behavior of the slow component of the lifetime of positrons annihilating in polyethylene was studied as a function of the gamma dose. (D.C.W.)

1003 DIRECT OBSERVATION OF NONLINEAR SCATTERING OF ELECTRONS BY LASER BEAM. Schwarz, H. (Rensselaer Polytechnic Inst., East Windsor Hill, Conn.); Tourtellotte, H. A.; Gaertner, W. W. Phys. Lett., 19: 202-3(Oct. 15, 1965).

The deflection of an electron beam intersecting a reflected laser beam at right angles was observed. The deflection angle agreed closely with the prediction of the Kapitza–Dirac theory, but the magnitude of the deflected beam was greater than was expected on theoretical bases. (D.C.W.)

1004 SUM RULES FOR MESON MESON INTERACTIONS. Muzinich, I. J.; Nussinov, S. (Univ. of Washington, Seattle). Phys. Lett., 19: 248-9(Oct. 15, 1965).

Some sum rules for meson-meson interactions are proposed. A sum rule related to meson (π)-meson (π) scattering is briefly discussed. (D.C.W.)

1005 ON THE LIFETIME OF THE η-MESON. Berends, F. A.; Singer, P. (CERN, Geneva). Phys. Lett., 19: 249-51(Oct. 15, 1965).

An estimate for the lifetime of the meson (η) was obtained on the basis of a theoretical calculation for the partial decay width of $\eta \rightarrow \pi^+\pi^-\gamma$ and the known experimental percentage of this partial rate. A total decay width of about 8 kev was obtained for the meson (η). This value is a factor of about 40 times larger than the previous theoretical estimates. (D.C.W.)

1006 MESON-BARYON SCATTERING AS A TEST OF THE COLLINEAR HYBRID GROUP $SU(6)_w$. Cini, M. (Univ., Rome). Phys. Lett., 19: 251-2(Oct. 15, 1965).

Some relations from $SU(6)_w$ symmetry were compared with experimental data for meson-baryon scattering processes. The predictions of $SU(6)_w$ were in strong disagreement with the available experimental data at low energies. (D.C.W.)

1007 A SEARCH FOR THE DECAY OF $\pi^0 \rightarrow 3\gamma$. Duclos, J. (CERN, Geneva); Freytag, D.; Schluepmann, K.; Soergel, V.; Heintze, J.; Rieseberg, H. Phys. Lett., 19: 253-5(Oct. 15, 1965).

An experiment is summarized in which an upper limit of $\leq 5 \times 10^{-6}$ was obtained for the branching ratio $R = (\pi^0 \rightarrow 3\gamma)/(\pi^0 \rightarrow 2\gamma)$ with 90% confidence. (D.C.W.)

1008 DIFFRACTION SCATTERING OF VIRTUAL PIONS AND THE A_1 ENHANCEMENT. Shen, Benjamin C.; Goldhaber, Gerson; Goldhuber, Sulamith; Kadyk, John A. (Univ. of California, Berkeley). Phys. Rev. Lett., 15: 731-4(Nov. 1, 1965).

The interactions π^+-p at 3.65 Bev/c and π^--p at 3.7 Bev/c, leading to $\rho^0\pi^+$p in the final state, were studied using a hydrogen bubble chamber. Evidence for diffraction scattering of virtual mesons(π) from the protons was obtained. The mass of the $\rho^0\pi^+$ system for the events associated with the diffraction scattering effect shows a considerable enhancement in the $A_1(1080)$ mass region. On the other hand e events in the $A_2(1320)$ mass peaks are not associate ith diffraction scattering. Thus, the A_1 enhancement ı be attributed to diffraction scattering of virtual meso π). (D.C.W.)

1009 K^+n CHARGE-EXCHANGE SCATTERING AT 2.3 Bev/c. Butterworth, Ian; Brown, John L.; Goldhaber, Gerson, Goldhaber, Sulamith; Hirata, Allan A.; Kadyk, John A.; Schwarzschild, Bertram M.; Trilling, George H. (Univ. of California, Berkeley). Phys. Rev. Lett., 15: 734-6(Nov. 1, 1965). (UCRL-16404).

The differential cross section for the interaction $K^+ + n \rightarrow K^0 + p$ at 2.3 Bev/c was determined by analysis of the differential cross section for the interaction $K^+ + d \rightarrow K^0 + 2p$. The forward-scattering cross section was compared with that derived from the optical theorem; the experimental value was considerably larger than the theoretical value, indicating that the charge-exchange amplitude is predominantly real. (D.C.W.)

1010 COMPARISON OF K* PRODUCTION IN THE REACTIONS $K^+ + n \rightarrow K^+ + \pi^- + p$ AND $K^+ + p \rightarrow K^0 + \pi^+ + p$ AT 2.3 Bev/c. Goldhaber, S.; Brown, J. L.; Butterworth, I.; Goldhaber, G.; Hirata, A. A.; Kadyk, J. A.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Rev. Lett., 15: 737-40(Nov. 1, 1965).

Peripheral K* production in the interactions $K^+ + n \rightarrow K^+ + \pi^- + p$ and $K^+ + p \rightarrow K^0 + \pi^+ + p$ was studied using a bubble chamber filled with deuterium. Marked differences in the distribution of four-momentum transfer to the K* and in the K* decay angular distributions for the two reactions were observed. The results are consistent with the production of K^{*0} in the former interaction by the exchange of an isovector meson(π), while the production of K^{*+} in the latter interaction primarily involves the exchange of an isoscalar meson(ω). (D.C.W.)

1011 ANALYSIS OF 3587 τ^+ DECAYS. Huetter, T.; Taylor, S.; Koller, E. L.; Stamer, P.; Grauman, J. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 140: B655-62(Nov. 8, 1965).

An analysis of 3587 $\tau^+ \rightarrow \pi^- + \pi^+ + \pi^+$ decay events is presented. These events were found in an area scanning of an emulsion stack of 600-μ Ilford G5 emulsion pellicles

exposed to a 300-Mev/c separated K^+ beam. The pion energy spectra are compared with the predictions of linear-matrix-element theory, the pion-pole model, and the s-wave resonance model, and with the existing spectra of the secondaries from η, $\tau^{\pm}$, τ', and K^0_S. (auth)

1012 SELF-CONSISTENT ρ TRAJECTORY IN THE NEW FORM OF THE STRIP APPROXIMATION. Collins, P. D. B.; Teplitz, Vigdor L. (Univ. of California, Berkeley). Phys. Rev., 140: B663-8(Nov. 8, 1965). (UCRL-16112).

The new form of the strip approximation, devised by Chew, is applied to the problem of bootstrapping a ρ trajectory in the π-π system. Even in the absence of other trajectories it is possible to obtain a self-consistent ρ trajectory and residue functions $\alpha(t)$ and $\gamma(t)$ for $t < 0$, with strip widths in the range 150 to 300 m_π^2. A particular example is given in detail. The absence of the force from other trajectories and the rapid variation of $\alpha(t)$ and $\gamma(t)$ for $t \geq 0$ mean that the results can not represent the real ρ trajectory, but at least they confirm the viability of the methods used. (auth)

1013 POLARIZATION OF A DECAY PARTICLE IN A TWO-STEP PROCESS: APPLICATION TO $K^- + p \rightarrow \pi^0 + \Sigma^0$, $\Sigma^0 \rightarrow \gamma + \Lambda$. Cha, Moon H. (Naval Ordnance Lab., Silver Spring, Md.; Univ. of Maryland, College Park); Sucher, J. Phys. Rev., 140: B668-75(Nov. 8, 1965).

The phenomenology of two-step processes of the type $A + B \rightarrow C + D$, $D \rightarrow E + F$ is studied for the particular case when among the final particles only F is observed. Formulas convenient for the computation of the polarization of F in terms of the parameters describing the production process are presented, and the connection between the polarization of F and that of D, when D is not observed, is clarified. Numerical results are obtained for the angular dependence of the Λ polarization in the process $K^- + p \rightarrow \pi^0 + \Sigma^0$, $\Sigma^0 \rightarrow \gamma + \Lambda$ at a variety of incident energies. (auth)

1014 ROLE OF THE BARYON EXCHANGES IN GENERATING $\frac{3}{2}^+$ RESONANCES. Dass, Guru Vachan; Choudhury, S. Rai (Univ. of Delhi). Phys. Rev., 140: B683-5(Nov. 8, 1965).

The role of the spin-$\frac{1}{2}$ baryon exchanges in generating the Ω^- is examined in the framework of the N/D method. The resulting integral equations are solved numerically to show that the baryon exchanges lead to an extremely overbound state. A comparison is also made between this and a determinantal-approximation calculation to show that an earlier calculation indicating a resonating Ω^- state is due to a deficiency in the determinantal approximation. (auth)

1015 KINEMATICS OF Λ-HYPERON β DECAY. Chu, William T. (Ohio State Univ., Columbus). Phys. Rev., 140: B685-7(Nov. 8, 1965). (COO-1261-11).

The distributions of several kinematical quantities are presented for the polarized Λ hyperon undergoing β decay. The basic couplings are assumed to be vector and axial-vector, and all the induced couplings are neglected. Special emphasis is placed on the kinematically invariant quantities and their asymmetries with respect to the polarization of the Λ hyperon. (auth)

1016 TEST OF THE NONRELATIVISTIC QUARK MODEL FOR ELEMENTARY PARTICLES: RADIATIVE DECAYS OF VECTOR MESONS. Becchi, C.; Morpurgo, G. (Univ., Genoa; Istituto Nazionale di Fisica Nucleare, Genoa). Phys. Rev., 140: B687-90(Nov. 8, 1965).

An experimental test of the nonrelativistic quark model proposed to describe the internal dynamics of elementary particles is suggested and discussed. In the nonrelativistic quark model, one can obtain not only the ratio $-\frac{3}{2}$ of the magnetic moment of the proton to that of the neutron, but also the absolute value of the magnetic moment of the proton in terms of the quark magnetic moment. By using the value of the quark magnetic moments determined in this way, the rates of the M1 radiative transitions $V \rightarrow P + \gamma$, where V is a vector meson and P a pseudoscalar meson, are calculated. The following results for the widths are obtained (in Mev): $\omega \rightarrow \pi^0\gamma$ (1.17); $\omega \rightarrow \eta\gamma$ (6.4×10^{-3}); $\rho \rightarrow \pi\gamma$ (1.2×10^{-1}); $\rho_0 \rightarrow \eta\gamma$ (4.4×10^{-2}); $K^{*+} \rightarrow K^+\gamma$ (7×10^{-2}); $K^{*0} \rightarrow K^0\gamma$ (2.8×10^{-1}); $\varphi \rightarrow \eta\gamma$ (3.04×10^{-1}). The result for the ω agrees with the present experimental data, assuming that the $\pi^0\gamma$ decay dominates the neutral decay rate of the ω; no experimental data are available for the other decays, and it is suggested that the $K^{*0} \rightarrow K^*\gamma$ and $\varphi \rightarrow \eta\gamma$ decay rates are sufficiently large to deserve a measurement. Two possible reasons for uncertainty are discussed in detail: (a) dependence of the vertex function upon the masses, and (b) choice of the ω and η unitary spin functions. (auth)

1017 CROSS-SECTION RELATIONS AND POLARIZATION IN A STATIC SU(6) MODEL. Renninger, G. H.; Videira, A. L. L. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 140: B691-7(Nov. 8, 1965).

Within the framework of a static (p-wave) SU(6) model, cross-section relations for the scattering of pseudoscalar mesons from baryons are found, and the polarization of the final baryon is investigated. The predicted value of 4/19 for the ratio $|M(K^-p \rightarrow K^+\Xi^-)|^2/|M(\pi^-p \rightarrow K^+\Sigma^-)|^2$ is found to be in agreement with experiment. In this model, it is predicted that for several reactions, including $K^-p \rightarrow K^+\Xi^-$ in which the Ξ^- is observed to be polarized near threshold, the p-wave part of the nonspin-flip and spin-flip amplitudes can not cause polarization. It is suggested that breaking of the symmetry may be able to account for the experimental polarization. (auth)

1018 DIFFERENTIAL CROSS SECTION FOR $e^+ + e^- \rightarrow W^+ + W^- \rightarrow e^- + \bar{\nu}_e + \mu^+ + \nu_\mu$. Tsai, Y. S.; Hearn, A. C. (Stanford Univ., Calif.). Phys. Rev., 140: B721-9 (Nov. 8, 1965).

The cross section $e^+ + e^- \rightarrow W^+ + W^- \rightarrow \mu^+ + \nu_\mu + e^- + \bar{\nu}_e$ in which e^- and μ^+ are detected in coincidence in the colliding-beam experiment is computed with the mass, magnetic moment, and leptonic mode branching ratio of the W boson as parameters. The kinematical correlations necessary for the identification and mass determination of the W meson are discussed. Numerical examples show that the energy-angle correlations of the final e and μ are very sensitive to the W mass. The analytical expression for the cross section was obtained by an electronic computer. The characteristics of dynamical correlations were investigated by numerical examples of angular distributions of e^- and μ^+ for different values of magnetic moment of W. It was found that the rate of increase of cross section with respect to the relative angle between the final electron and muon is the most sensitive dynamical correlation needed for the determination of the W magnetic moment. The possibility that W may have form factors and an anomalous quadrupole moment is ignored. Symmetries in the differential cross section are discussed. Because of one-photon exchange, the differential cross section e^- and μ^+ must be symmetric with respect to the plane perpendicular to the incident beam. Because of time-reversal invariance, the differential cross section for μ^+ must be symmetric with respect to the plane formed by the incident beam and the final electron. Similarly the differential cross section for e^- must be symmetric with respect to the plane formed by the incident beam and the μ^+. It is also shown that the charge-conjugate decay mode $e^+ + e^- \rightarrow W^+ + W^- \rightarrow \mu^- + \bar{\nu}_\mu + e^+ + \nu_e$ can be obtained from the result by simply putting $\mu^+ \rightarrow \mu^-$ and $e^- \rightarrow e^+$ in the final state if only the lowest order process is considered. It is pointed out that the techniques used can be employed to calculate many other processes in which two unstable particles are produced. (auth)

1019 DOUBLE RESONANCE PRODUCTION BY 2.77-Bev/c π^+ MESONS ON HYDROGEN. Yamamoto, S. S.; Smith, J. R.; Rahm, D. C.; Lloyd, J. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 140: B730-5 (Nov. 8, 1965). (BNL-9193).

Reactions $\pi^+ + p \rightarrow \pi^+ + \pi^+ + \pi^- + p$, $\pi^+ + p \rightarrow \pi^+ + \pi^+ + \pi^+ + \pi^- + p + \pi^0$, and $\pi^+ + p \rightarrow \pi^+ + \pi^+ + \pi^+ + \pi^- + n$ were studied at an incident π^+ momentum of 2.77 Bev/c. The first reaction is dominated by a quasi-two-body intermediate state $\rho + N^*$. The decay distributions of ρ and N^* are consistent with the predictions of the single-pion-exchange model. The ρ^0 decay distributions show the well-known

asymmetry, which may be attributed to an interference with a T = 0 even-spin background. The second reaction is dominated by a quasi-two-body intermediate state ω + N*. The decay distributions of ω and N* are not consistent with the unmodified ρ-exchange model, but could be made to be consistent by including the absorptive effects in the output channels. The last reaction shows no prominent resonance production. (auth)

1020 WEAK N* PRODUCTION AND SU(6). Albright, C. H.; Liu, L. S. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 140: B748-61(Nov. 8, 1965).

A phenomenological study is made of the weak N* production process by displaying the matrix element in terms of eight form factors. Simple functional dependences are adopted for these form factors, and analytical expressions for the cross sections are given in detail. A numerical analysis is carried out to investigate the effectiveness of each form factor. Three models are proposed for this process: one assumes the dominance of a single form factor, another incorporates information obtained from N* photoproduction, and the third employs the SU(6) relations of Bég and Pais. All three models are compatible with present experimental information, but the one derived from the SU(6) theory is the most encouraging. (auth)

1021 REGENERATION EFFECTS AND THE COMPLETE EXPERIMENT IN A K^0-MESON BEAM. Vladimirskii, V. V.; Terent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 2: 265-71(Aug. 1965). (In Russian).

Regeneration effects in a beam of neutral K-mesons are studied, considering CP and possibly CPT parity violation. A set of experiments is discussed, which is in principle sufficient to determine all the parameters, characterizing the regeneration and the degree of CP and CPT violation. (auth)

1022 THE $K \rightarrow 2\pi$ DECAY AND SU(3) SYMMETRY. Volkov, D. V.; Kuraev, E. A. Yadern, Fiz., 2: 272-6(Aug. 1965). (In Russian).

The $K \rightarrow 2\pi$ decay is considered on the basis of a dynamical model, suggested by Coleman and Glashow. Two variants of this model are discussed. In the first one only transitions of scalar particles, belonging to the unitary octet, into vacuum, are considered. In the second, improved variant the octet of scalar particles also figures in the intermediate states with the lowest energy. It is shown that the improved variant leads to a strong suppression of the $K^+ \rightarrow \pi^+\pi^0$ decay for the values of scalar particle masses, considered in paper. (auth)

1023 BREMSSTRAHLUNG AND THE LIFETIMES OF RESONANCES. Solov'ev, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 2: 277-86(Aug. 1965). (In Russian).

A method is considered, in which the widths of narrow resonances are measured by investigating the spectrum of bremsstrahlung, accompanying the reaction $1 + 2 \rightarrow \{A\} + X \rightarrow \{A\} + \{B\}$. It is shown that the bremsstrahlung differential cross section has a resonance at the frequency $\omega = \Gamma\sqrt{1-\beta^2}/(1-n\beta)$ where Γ is the width of the resonance X, n the emission direction and β the velocity of the resonance X in the reaction $1 + 2 \rightarrow X + \{A\}$. The possibility of applying the method to measure the width of the η^0-meson is discussed. (auth)

1024 PHOTON EMISSION IN THE ELECTROMAGNETIC ANNIHILATION OF HEAVY PARTICLES. Baier, V. N.; Khoze, V. A. (Novosibirsk State Univ., USSR). Yadern. Fiz., 2: 287-93(Aug. 1965). (In Russian).

It is shown that a peak exists in the hard part of the photon spectrum, emitted by the initial particles if a photon is created in the electromagnetic annihilation of a pair of particles. This means that hard photons are mostly emitted by the initial particles. Possible applications of this effect are discussed. (auth)

1025 EXPERIMENTAL DATA ON RESONANCE WIDTHS AND SU(3)-SYMMETRY PREDICTIONS. Marinov, M. S. (Inst. of Theoretical and Experimental, Moscow). Yadern. Fiz., 2: 321-5(Aug. 1965). (In Russian).

Theoretical and experimental relations between the partial widths of strong decays are compared in the vector meson octet, baryon decuplet and baryon $3/2^-$ and $5/2^+$ octets. The inclusion of the Ξ^* (1820) particle in the $3/2^-$ octet is in contradiction with data on its partial widths. The possibility of introducing a form factor in the decay amplitude is discussed. (auth)

1026 THE ROLE OF ONE-DIMENSIONAL INTEGRALS IN THE MANDELSTAM REPRESENTATION FOR THE γ-QUANTUM COMPTON SCATTERING OF PROTONS. Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 2: 352-60(Aug. 1965). (In Russian).

One-dimensional dispersion relations with respect to s and u, with one substraction, are obtained for the invariant amplitudes $T_i(s,t)$ on the basis of the double dispersion relations. The influence of the spin structure of the amplitudes for the elastic scattering of γ-quanta on protons is taken into account for the double dispersion relations. The substraction function is found with the help of dispersion relations with respect to t and the low energy limit. The obtained dispersion relations are investigated under the assumption, that all higher waves in the photoproduction amplitude are determined by the retarded term. This assumption implies, that the asymptotical behavior of the function $T_i(s,t) - T_i(s,0)$ for $s \rightarrow \infty$ is determined by a quasilocal term, equal to the sum of the poles in channel III plus integrals of functions, which can be expressed with the help of the unitarity condition only in the channel III. A numerical analysis is performed. (auth)

1027 STUDY OF ETA PRODUCTION AND ITS CHARGED DECAY MODES [Thesis]. Foster, Margaret Carter. Madison, Wis., Univ. of Wisconsin, 1965. 104p.

In an exposure of 1.215 and 1.267 Bev/c π^+ mesons in a hydrogen bubble chamber, the production of the eta and its charged decay modes were studied. The cross section for the reaction $\pi^+ + p \rightarrow \pi^+ + p + \eta$, $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ is 62.9 ± 8.2 μb at 1.215 Bev/c and 130.3 ± 18.4 μb at 1.267 Bev/c. The cross section for the reaction $\pi^+ + p \rightarrow \pi^+ + p + \eta$, $\eta \rightarrow \pi^+ + \pi^- + \gamma$ is 14.8 ± 3.7 μb at 1.215 Bev/c and 17.4 ± 6.2 μb at 1.267 Bev/c. The branching ratio $\Gamma(\eta \rightarrow \pi^+ + \pi^- + \gamma)/\Gamma(\eta \rightarrow \pi^+ + \pi^- + \pi^0)$ is 0.196 ± 0.041. The energy spectrum of the pi zero in the decay $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ was studied. The dalitz plot for the decay $\eta \rightarrow \pi^+ + \pi^- + \gamma$ is presented. The data indicate that the production may proceed through the process $\pi^+ + p \rightarrow N^{*2+} + \eta$ in a mixture of angular momentum states J = 0 and J = 1. (Dissertation Abstr.)

1028 AN EXPERIMENTAL STUDY OF $K^+ \rightarrow \pi^+ \pi^0 \pi^0$ DECAYS [Thesis]. Dowd, Richard Michael. Madison, Wis., Univ. of Wisconsin, 1965. 88p.

Development of the $\Delta I = 1/2$ rule as it applies to nonleptonic strangeness changing decays is reviewed. Film from a bubble chamber, filled with C_3F_8, was scanned for $K^+ \rightarrow \pi^+ \pi^0 \pi^0$ (τ') from stopping K^+'s. The final result gives the linear term in the matrix element as a function of the Mandelstam variable as $-.24 \pm .02$. The spectrum is incompatible with the σ resonance. The same film was scanned for the same decay with two converted γ rays pointing at the origin to study the π^0 spectrum. The resulting spectrum shows no dependence in the suitable Mandelstam variable, as expected. Finally the results for the τ' decay mode are compared with other modes, showing consistency with the $\Delta I = 1/2$ rule and with the pion pole model. (TCO)

1029 TWO-PION EXCHANGE CONTRIBUTION TO THE HIGHER ANGULAR MOMENTUM NUCLEON-NUCLEON PHASE SHIFTS [Thesis]. Durso, John William. University Park, Pa., Pennsylvania State Univ., 1964. 108p.

The two-pion exchange contribution to the higher ($l > 2$) angular momentum phase shifts in nucleon-nucleon scattering is calculated using the single dispersion relation approximation to the Mandelstam representation developed

by Cini and Fubini. Only the singularities in the scattering amplitude nearest the physical region of the kinematic variables are taken exactly into account while the effect of more distant singularities is absorbed into arbitrary constants. A simple model for the complete pion-nucleon amplitude is assumed and is related to the amplitude for nucleon-antinucleon annihilation into two pions by use of the crossing symmetry of the Mandelstam representation. The single spectral functions in the Cini-Fubini approximation are then calculated by application of the unitarity condition of the S-matrix in the nucleon-antinucleon channel. The contribution to the scattering amplitude in the nucleon-nucleon channel is obtained by further application of crossing symmetry. The calculated two-pion contribution yields reasonable corrections to the one-pion exchange phase shifts. (TCO)

1030 A FIELD-THEORETIC APPROACH TO THE ρ-MESON [Thesis]. Alexanian, Moorad Bloomington, Ind., Indiana Univ., 1964. 106p.

A technique of improving the perturbation series is applied to the pion-pion interaction lagrangian $4\pi\lambda(\phi_\alpha\phi^\alpha)^2$. The improved amplitudes are considered beyond the constant phase regions, giving a one-parameter theory for low energy pion-pion scattering. The Matthews-Salam equations are obtained using the interaction lagrangian $\frac{1}{4}\, g(\phi_\alpha\phi^\alpha)^2$ and solved for the τ-functions as a perturbation expansion in the unrenormalized coupling constant g. The invariant amplitude $A^{(T)}$ is introduced and expanded into partial waves. The renormalized pion-pion coupling constant is introduced through the value the invariant amplitudes take at the symmetry point, thus eliminating the integration constants for the amplitudes $A^{(0)}$ and $A^{(2)}$ in favor of λ. In order to determine the constant of integration associated with the $A^{(1)}$ amplitude, the crossing symmetry which relates the T = 1 amplitude to the T = 0 amplitudes in the crossed channels is used. The improved s-wave amplitudes for isotopic spin T = 0 and T = 2 satisfy elastic unitarity. The improved amplitude approaches the perturbation series result in the limit of small coupling constant, and thus, for small values of the coupling constant, crossing symmetry is satisfied by the improved amplitudes. The phase shifts are obtained from the improved amplitudes. For the p-wave, T = 1 amplitude, since $A^{(1)}$ is real up to and including the λ^3 term, the consideration of the improved amplitude to get phase shifts must be replaced by considering the phase shifts directly, and deriving improved phase shifts. The T = 1, p-wave improved phase shifts are real and a resonance occurs for negative values of λ with $|\lambda| \lesssim 0.9$. Negative values of λ give rise to repulsive s-wave scattering lengths. The T = 1, p-wave resonance occurs at the position of the ρ-meson resonance for $\lambda = -0.21$, with a width $\Gamma = 100$ Mev. Crossing symmetry, together with the improving technique, imposes a numerical restriction on the value of the renormalized coupling constant λ, $\lambda \lesssim 0.49$. Since the improved phase shifts are real, elastic unitarity is automatically satisfied. Crossing symmetry for the T = 1 improved amplitude is satisfied in the same sense as for the T = 0 and T = 2 improved amplitudes. (TCO)

1031 PION-DEUTERON PRODUCTION, $p + p \rightarrow \pi^+ + d$, AND TRANSVERSE MOMENTUM DISTRIBUTIONS IN HIGH ENERGY PHYSICS [Thesis]. Ulrich, Bruce Truman. Ithaca, N. Y., Cornell Univ., 1964. 99p.

Differential cross sections for $p + p \rightarrow \pi^+ + d$ reaching deuteron transverse momenta $p_\perp$ of 1.70, 1.66, and 1.75 Bev/c at incident proton laboratory momenta 11.6, 15.0, and 22.9 Bev/c respectively were measured. The measurements indicate that at high energies (total center-of-mass energy squared, $s > 10$ $(\text{Bev})^2$) and high transverse momenta the pion-deuteron cross section follows the same exponential law $d\sigma/d\Omega \propto (1/s) \exp(-a_{\pi d} p_\perp)$, with empirical decay constant $1/a_{\pi d} = .16$ Bev/c observed in proton-proton elastic scattering. A model based on the pion-production exponential transverse momentum distribution related $p + p \rightarrow \pi^+ + d$ to the $p + p \rightarrow \pi^+ + n + p$ reaction. The single-pion-production differential cross section is written in the form $d\sigma_{\pi ap} = A(s) \int_C g(k, p_\pi, p_p) d^{12}R$, where $d^{12}R$ is an element of invariant phase space for the outgoing particles, $d^{12}R = \delta^{(4)}(p_{in} - k - p_n - p_p)\, \delta(k^2 - \mu^2)\, \delta(p_n^2 - M^2)\, \delta(p_p^2 - M^2)\, d^4k d^4p_n d^4p_p$. The quantities k, p_π, p_p, and p_{in} are the pion, neutron, proton and total initial four-momenta respectively, and μ and M are the pion and nucleon masses respectively. The result after integration gives a good fit to the data with $s > 12$ $(\text{Bev})^2$ if $\sigma(s) \sim (1/s)^n$, $n = 1.3 \pm .3$. (TCO)

1032 PHILOSOPHICAL PROBLEMS OF ELEMENTARY PARTICLE PHYSICS. Kuznetsov, I. V.; Omel'yanovskii, M. E. (eds.). New York, Daniel Davey and Co., Inc., 1965. 300p. $15.25.

Translation by A. Sen and R. N. Sen from Filosofskie Problemy Fiziki Elementarnykh Chastits.

Twenty papers are included; separate abstracts have been prepared for each. (L.B.S.)

For abstracts of individual chapters see: 1033—1051 and 1080.

1033 THE CORRELATION BETWEEN PHYSICAL THEORIES AND THE DEVELOPMENT OF CONTEMPORARY ELEMENTARY PARTICLE PHYSICS. Kuznetsov, I. V. pp 1-11 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

An attempt is made to consider the various forms of correlation and succession among physical theories belonging to qualitatively different stages of development. Stress is placed on analysis of the forms with reference to the contemporary theory of elementary particles. (L.B.S.)

1034 CERTAIN ASPECTS OF THE CONTEMPORARY DEVELOPMENT OF ELEMENTARY PARTICLE THEORY. Berestetskii, V. B. pp 12-15 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

Recent progress in the development of elementary particle theory is noted; the important shifts occurring in the principal concepts, with cardinal changes in the formulation of the problems, in the methods and in the attitude toward the aims of the theory. A characteristic trait of the development is considered, which stems from the relation between phenomenological description and theoretical explanation. (L.B.S.)

1035 CERTAIN FEATURES SPECIFIC TO THE QUANTUM THEORY OF ELEMENTARY PARTICLES. Fainberg, V. Ya. pp 16-24 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

The three fundamental characteristics of the relations revealed by nonrelativistic quantum mechanics are briefly discussed, stressing their profound dissimilarity from the classical laws. The characteristics are due to the finiteness of Planck's constant h. The new elements introduced into nonrelativistic quantum mechanics and its generalization to the region of relativistic energies are outlined. It is shown that the most characteristic tendency in the development of the theory, as it is extended to the region of relativistic energies, is as follows: increasingly deep and consistent rejection of the applicability of classical concepts in small space-time regions, increasingly abstract characterization of the state, and increasingly limited space-time visualization. (L.B.S.)

1036 THE PROBLEMS OF MODERN ASTRONOMY AND PHYSICS OF THE MICROWORLD. Ambartsumyan, V. A. pp 25-32 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

The philosophy of science is of considerable significance for astronomy. Definite philosophical views on nature frequently serve as a foundation for setting up and solving many far-reaching problems of natural science, including the science of the universe. If correct philosophical views are held a correct approach to the solution of concrete problems of natural science can also be evolved. In particular it is entirely possible that such an approach would

lead to more rapid discarding of preconceived notions resulting from insufficient knowledge of philosophy on the part of the given investigator or from his utilization of a poor philosophy. By providing a firm foundation for the thesis that matter is inwardly infinite and inexhaustible and the properties of the material world manifold, Marxist philosophy compels the investigator constantly to seek manifestations of new, still unrevealed regularities of nature, and to find deep relationships between phenomena which at first glance seem scarcely related. The diversity and depth of the relationships between different phenomena of the material world may be illustrated by the one which relates certain regularities of the astronomical universe and the physics of the microworld. A few aspects of this relationship are considered. (auth)

1037 PROBLEMS OF THE STRUCTURE OF ELEMENTARY PARTICLES. Blokhintsev, D. I. pp 33-43 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

At the present time sixteen elementary particles and roughly the same number of antiparticles are known. Were this list expanded to include the very short-lived particles — "isobars" or "resonance states" — the total number of particles now known would reach forty. Most of these particles are unstable: they decay, ultimately transforming into a small number of stable particles, i.e., electrons and protons, γ-quanta and neutrinos or into the corresponding antiparticles, which are also stable. The elementary particle world is exceptionally rich both with regard to the diversity of particles proper and to the forms of interaction and transformation between them. There now exists a more or less satisfactory systematics of particles and logical classification of particle interactions. All of these classifications, however, are still very far from presenting a unified picture; the established forms of particles and interactions still remain unrelated. On the other hand the materialistic physicist can scarcely fail to believe that there exist profound internal causes which determine both the properties of elementary particles and their very existence. Particles must also possess an internal structure which determines their global characteristics – including those quantum numbers which serve as characteristics of the individual baryons, mesons or leptons. In this connection the problem of the internal structure of particles is considered. (auth)

1038 THE PROBLEM OF THE ELEMENTARITY OF PARTICLES IN QUANTUM PHYSICS. Omel'yanovskii, M. E. pp 44-54 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

The ideas involved in quantum field theory, which effected a deeper synthesis of corpuscular and wave pictures of matter, are considered. It is shown that this theory is an example of the laws of dialectics. The theory of elementary particles is thus considered as a graphic demonstration that the principles operative at the foundations of knowledge of matter are the principle of development, principle of unity of matter, dialectic principle of contradiction and other important principles of dialectic materialism. The problem of elementarity of particles is investigated from the standpoint of this philosophical approach. (L.B.S.)

1039 CONSERVATION PRINCIPLES AND THE PROBLEM OF THE STRUCTURE OF MATTER. Ovchinnikov, N. F. pp 55-74 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

Every physical theory has conservation principles among its fundamental laws. These principles are the foundation of finished theories as well as the starting point of emerging theories. Conservation principles can be defined as requirements that certain quantities which enter into the system of concepts of a given theory be constant. Further, the conserved quantities can be expressed in a variety of mathematical forms and can have different physical contents. The term conservation principles is used to mean equally conservation of things, conservation of properties and conservation of relations. Therefore the conservation laws known in the physics of elementary particles, which express the conservation of properties (electric charge, spin, isotopic spin, baryon charge, lepton charge, strangeness and so on) constitute merely a partial class of conservation principles. Henceforth all conservation laws operative in elementary particle physics are considered as conservation principles. A brief characterization of these principles is given while tracing the logical necessity for introducing given conserved parameters into the theory as knowledge concerning the laws of motion of elementary particles and the structure of matter develops further and further. The classical conservation principles — conservation of mass, energy, momentum and angular momentum — are fulfilled in the physics of elementary particles. These principles are of a general character and their validity in the elementary particle region is evidence of the profound unity of nature. The specific conservation principles characteristic exclusively of microparticle physics are treated. These conservation principles are indeed the basis of the specific laws of motion of the fundamental particles of matter. (auth)

1040 THE PROBLEM OF THE SPATIAL STRUCTURE OF ELEMENTARY PARTICLES. Terletskii, Ya. P. pp 75-81 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

The idea of finite spatial dimensions and of spatial structure of elementary particles is considered in the light of its contradiction with certain concepts and consequences of relativistic quantum theory. (L.B.S.)

1041 A CRITERION OF RELATIVE ELEMENTARITY. Pakhomov, B. Ya. pp 82-91 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

The concept of universal unity as dialectical materialism is considered, in which the material unity of the universe is the unity of qualitatively different kinds of matter and forms of motion of the latter; thus intertransmutations (unity) are seen as fundamental qualitative changes (dissimilarity). The problem is formulated as follows: is the microworld a single form of motion of matter or is it, in turn, the contradictory unity of qualitatively different forms of matter and of motion? The existence of internal dissimilarities in elementary particles is considered in this sense. The problem of the criterion of relative elementarity is treated from the following point of view: if all microparticles are related to a single qualitatively distinct form of motion of matter, they may be regarded as equally elementary. If there are several qualitatively different forms, the more elementary particle will be the one associated with fewer forms of motion. (L.B.S.)

1042 A PHILOSOPHICAL EVALUATION OF MODERN IDEAS CONCERNING THE PROPERTIES OF SPACE AND TIME IN THE MICROWORLD. Melyukhin, S. T. pp 92-117 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

So far there exists no fully-developed physical theory of space and time in microphenomena. The theory of relativity, which was based on a generalization of classical electrodynamics and of some experiments in the realm of microphenomena, characterizes the properties of space and time primarily in the region of macroscopic processes and tells us very little about their features in the microworld. Modern elementary particle theory also fails, at least so far, to give a complete picture of space-time relations in this region. Nevertheless modern ideas concerning space and time in the microworld already contain a number of philosophical problems of fundamental significance for all understanding of the microworld. An attempt is made to analyze the philosophical significance of modern ideas on space and time in the microworld, and also to establish the correlation

between their general and their specific properties. (auth)

1043 SPACE-TIME QUANTIZATION IN ELEMENTARY PARTICLE THEORY. Shapiro, I. S. pp 118-26 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

A brief sketch is presented of the difficulties associated with the theory of elementary particles. The first group of difficulties is due to the inability of solving the equations of the quantum theory of interacting fields; the second stems from the fact that no principles can be seen in the modern theory by which diversity of the known elementary particles can be explained and the connection between the various types of particle interactions can be established. Mention is made of an attempt to circumvent these difficulties by use of the dispersion relations. The important hypotheses proposed for space-time quantization—those of Snyder (1947) and Coish (1959)—are discussed. (L.B.S.)

1044 THE PROBLEM OF SPACE AND TIME IN ELEMENTARY PARTICLE PHYSICS. Aronov, R. A. pp 127-31 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

It is shown that the basic premise of modern elementary particle physics—that the properties of space and time do not depend on the interactions of material objects—and the dilemma which follows from it—the properties of elementary particles are due either to the peculiarities of interactions or the properties of space and time—are not adequate to reality, and therefore cannot assist in the further successful development of elementary particle physics. It is believed that further successful development of elementary particle physics is possible only if it is based on a dialectical-materialism conception of the interrelation of space, time and the motion of matter and on the hypothesis of the discontinuity of space and time. (L.B.S.)

1045 QUANTUM PHYSICS AND THE TRANSMUTABILITY OF ELEMENTARY PARTICLES. Omel'yanovskii, M. E. pp 132-43 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

Two features of the dialectical view of motion and the development of matter are emphasized: firstly, motion, the development of phenomena and processes in the world, is a struggle of opposites, the division of a unity into mutually exclusive opposites and their reciprocal relation; and secondly, development as unity of opposites implies that the unity of opposites is relative, whereas the struggle of opposites is absolute. A discussion is presented on the following question; does the dialectical conception of development cover the data on the transmutability of the elementary particles which, according to the ideas of modern physics, lie at the foundation of known matter? Exact conservation laws, approximate conservation laws, symmetries of classical physics, of the theory of relativity, and of quantum theory are considered. (L.B.S.)

1046 THE DEVELOPMENT OF THE STUDY OF ELEMENTARY PARTICLES AS COGNITION OF INCREASINGLY PROFOUND REGULARITIES OF THE MICROWORLD. Sokolov, A. A. pp 144-57 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

An attempt is made to analyze the causes which, in the microworld, lead to regularities which are more complex than those in classical mechanics. It is pointed out that with the appearance of experimental data on the structure of elementary particles and their interaction with the vacuum fluctuation, the artificial restrictions placed upon the ability to cognize the microworld by the principle of complementarity cannot be of assistance in the further development of the science. The consideration of vacuum fluctuations for the study of problems of quantum electrodynamics is discussed. It is further pointed out that elementary particles can be related to each other and to the vacuum not only by electromagnetic interactions but also by the weak and strong interactions, and that one of the most important problems of the theory of strong interactions is to construct a unified theory of fields in which particles may be regarded as excited vacuum states. It is concluded that the regularities of the microworld depend neither upon the instrument nor the observer, but should be approached from the standpoint of dialectic materialism. (L.B.S.)

1047 AN EVALUATION OF THE SIGNIFICANCE OF STATISTICAL REGULARITIES IN ELEMENTARY PARTICLE PHYSICS. Sachkov, Yu. V. pp 158-78 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

Various approaches to the treatment of statistical irregularities are considered, in which is pointed out that the transition from the direct characterizations of probability distributions to wave functions made it possible to link the laws of motion to definite internal properties of physical objects and thus made it possible to study the properties and laws of behavior of individual microobjects on the basis of quantum theory, the laws of which are in principle statistical. The use of group theoretical methods in the development of classification schemes for the elementary particles is discussed. The classification schemes view the analysis of elementary particles from the standpoint of revealing their internal structure and make it possible to express the definite asymmetry in the structure of the particles. (L.B.S.)

1048 CAUSALITY AND DETERMINISM IN QUANTUM THEORY. Svechnikov, G. A. pp 179-98 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

An attempt is made to explain the specific traits of causal relations in microphysics; what new elements has quantum physics contributed to the ordinary ideas concerning causality, and what is the part played by the principle of causality in the investigation of microprocesses? The concepts of causality and determinism are defined, and the relation between them is explained. (L.B.S.)

1049 THEORY AND EXPERIMENT IN MICROWORLD PHYSICS. Zhdanov, G. B. pp 207-31 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

Some of the general features of modern experiment and modern theory are presented and certain aspects of the union and interaction of these two fields of scientific activity are outlined. (L.B.S.)

1050 VISUALIZABILITY AND MODELS IN THE THEORY OF ELEMENTARY PARTICLES. Novik, I. B. pp 232-60 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

A philosophical analysis is presented of certain aspects of model construction for clarifying the role of models in the development of the theory of elementary particles. It is conjectured that the first important feature of model construction in modern physics is the reduction of the element of sensory visualizability; its second feature is the increase, in cognition, of the role of models consisting of logical elements. An analysis is made of the prospects for logico-mathematical models, and examples are presented of phenomenological models which are solvable. (L.B.S.)

1051 THE THEORY OF ELEMENTARY PARTICLES AND INFORMATION THEORY. Akchurin, I. A. pp 261-80 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

Some methodological approaches drawn from experiences in the creation of the theory of relativity and quantum mechanics are considered from the standpoint of forseeing the mathematical apparatus which will be used in the future general theory of elementary particles. An attempt is made to determine by the use of information theory a few quantitative criteria by which those highly abstract objects

which can be used to create abstract mathematical models of processes in the elementary particle world can be distinguished from those which cannot. A general definition of the amount of information is given, nonrigorous qualitative considerations relating to the information capacity of various mathematical objects are presented, and an ontological hypothesis concerning the nature of the different levels of structure of matter is formulated. (L.B.S.)

1052 ANTIPROTON-PROTON INTERACTIONS IN FLIGHT. Ferbel, T. (Yale Univ., New Haven). 36p. (CONF-650653-3). Gmelin, AED-CONF-65-170-9.

From American Physical Society, Summer Meeting, New York.

A brief summary of some of the characteristics of antiproton-proton interaction in flight is presented, and the reaction mechanisms for the process $\bar{p} + p \rightarrow N^{*++} + N^{*--}$ are discussed. (J.F.P.)

Field Theory, Scattering Theory, and Symmetries

See also Elementary Particles and Radiations

Refer also to abstract 737.

1053 (JINR-P-2321) INTEGRAL'NYE PREDSTAVLENIYA PELYATIVISTSKIKH AMPLITUD V NEFIZICHESKOI OBLASTI. (Integral Representations of Relativistic Amplitudes in the Nonphysical Region). Kuznetsov, G. I.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 20p. Dep. mn.

The methods of integral geometry are used to expand the amplitudes in the nonphysical regions of the Mandelstam plane in the eigenfunctions of the Laplace operator on three-dimensional manifolds. The inverse transformation formulas are given. (auth)

1054 (JINR-P-2328) ON THE MATRIX ELEMENTS FOR INELASTIC SCATTERING OF HEAVY PARTICLES. [PART] II. Grabovskii, Ya.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 9p. Dep. mn.

The orbital representation of the matrix elements of inelastic scattering of heavy particles ($E > V_B$) was considered. Conclusions from a previous article are generalized to the case in which account is taken of the energy losses and the projections of the momentum transfer different from zero. (auth)

1055 (JINR-P-2338) O STRUKTURE VERSHINNYKH CHASTEI V SIMMETRIYAKH SL(6) I U(12). (On Structure of Vertex Parts in Symmetries SL(6) and U(12)). Nguyen Van Hieu; Fam Kugh Tu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 17p. Dep. mn.

The relation between the group SL(6) and $\tilde{U}(12)$ and between their representations is treated. It is shown that each irreducible representation of the group $\tilde{U}(12)$ includes different irreducible representations of the group SL(6). The relation between the vertex parts in these symmetries is also considered. Relations were obtained between the matrix elements of leptonic meson decays in weak and electromagnetic interactions as consequences of the symmetries SL(6) and $\tilde{U}(12)$. (auth)

1056 (NP-15536) ON THE REPRESENTATION THEORY OF THE GROUP SU_3 [Thesis]. Kleima, Dirk (Groningen Rijksuniversiteit (Netherlands)). 1965. 69p. Dep. mn.

Some aspects of the representation theory of the SU(3) group are treated. After a survey of preliminary matter, the differential operator method is explained for the group SU(2). A set of polynomials in 3 + 3 variables was obtained which spans all irreducible representations and implicitly also contain the Clebsch–Gordan coefficients for the coupling of any two triangle representations of opposite type. These coefficients are expressed in ordinary SU(2) Clebsch–Gordan coefficients for infinite dimensional representations. It is shown that the polynomials previously obtained are identical to Beg and Ruegg's spherical harmonics in unitary three-space and their methods are extended to unitary n-space. Another type of polynomial is introduced which contains the Clebsch–Gordan coefficients for the coupling of any two triangle representations of the same type. (M.O.W.)

1057 (UCRL-16366) DYNAMICS OF A SINGLET AND AN OCTET OF $D_{3/2}$ MESON–BARYON COMPOSITE STATES [Thesis]. van der Merwe, Paul du T. (Lawrence Radiation Lab., Univ. of California, Berkeley). Aug. 26, 1965. Contract W-7405-eng-48. 64p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The $D_{\frac{3}{2}}$ meson-baryon resonances are investigated on the basis of a multichannel Bethe-Salpeter equation in the unitary symmetry limit. The driving mechanism consists of a box diagram which provides strongly attractive D-state forces corresponding to the unitary singlet and octet states. A reduction of the Bethe-Salpeter equation to a single-dimensional relativistic integral equation which incorporates two-body unitarity is effected along the lines of a method of Blankenbecler and Sugar. The equation is solved by the determinantal method. The model accounts for a singlet and gamma octet of composite states. Relevant results on the application of the methods of parity and helicity amplitudes to integral equations are presented. (auth)

1058 SYMMETRY GROUPS OF A SIMPLE THREE-PARTICLE SYSTEM. Kramer, P. (Universitaet, Marburg, Ger.; U. N. A. M., Mexico City). Ann. Physik (7), 15: 278-86(1965). (In German).

A spinless non-relativistic three-body system with oscillator interactions between particles of different mass was considered. From the symmetry group U_6 of the system, four chains of subgroups were derived describing different correlations between the particles. Pertinent sets of operators were built from the U_6 generators. The recoupling of the relative coordinates led to "kinematic transformations" of the eigenfunctions of these operators. (tr-auth)

1059 MASS QUANTIZATION OF HALF-SPIN PARTICLES. Lagu, A. V.; Lele, S. V. (Banaras Hindu Univ., Varanasi, India). Current Sci. (India), 34: 553-4(Oct. 5, 1965).

It was previously shown for zero-spin particles that both real and imaginary time co-ordinate transformations lead to the same condition for mass quantization although the two transformed wave equations become invariant under orthogonal and Lorentz transformations respectively. It can be shown for half-spin particles considered here, that the conditions can again be obtained by considering the transformation $x \rightarrow ix$, $y \rightarrow iy$, $z \rightarrow iz$, $t \rightarrow it$. It is noted that the solution is identical with that obtained by Stephenson for zero-spin particles. Further the solutions lead to mass quantization independently, but are incompatible with each other. (auth)

1060 RIGOROUS SYMMETRIES OF ELEMENTARY PARTICLES. Ekstein, H. (Argonne National Lab., Ill.; Universite, Aix-Marseille, France). pp 150-80 of Ergebnisse der Exakten Naturwissenschaften. 37 Band. Berlin-New York, Springer-Verlag, 1965.

The structure of rigorous symmetries of elementary particles is analyzed. (D.C.W.)

1061 AN IMAGE SOURCE TECHNIQUE FOR CALCULATING REFLECTION OF GAMMA RAYS OR NEUTRONS. Eisenhauer, C. (National Bureau of Standards, Washington, D. C.). Health Phys., 11: 1145-54(Nov. 1965).

A simplified representation for the problem of a point source and point detector located above an interface is discussed. It is shown that the geometrical effects can be taken into account by a simple scaling function. For a given material and radiation the remaining effects depend primarily on one angular variable with only a sec-

ondary dependence on the ratio of source distance to detector distance from the interface. Applications are made to neutrons, gamma rays, and particles, the energy of which does not change with scattering (one-velocity case). The analogous representation for problems in transmission of radiation through slabs is also discussed. (auth)

1062 SOME NEW MATHEMATICAL FEATURES IN CASCADE THEORY. Ramakrishnan, Alladi (Inst. of Mathematical Sciences, Madras); Vasudevan, R.; Srinivasan, S. K. J. Math. Anal. Appl., 11: 278-89(July 1965).

The fluctuation problem in cascade theory is viewed from the standpoint of the invariant-imbedding method of Bellman. The correlation functions that are used in the description of the electromagnetic cascades are shown to obey a simple system of two component vector differential equations. The advantage of the present method over the conventional approach of writing down Kilmogorov forward equations for these functions lies in that only 2×2 matrices of a particular type are encountered. In view of the simplicity of the structure, it is possible to generalize the equations to correlation functions of arbitrary order. The reduction in dimension from $2^n \times 2^n$ matrices to only 2×2 matrices which may, at first sight, appear perplexing is due to the fact that each of the 2^n elements that appear in the single system of differential equations, corresponding to the two different initial conditions, can be obtained by considering 2^n disjoint systems of two component vector equations. The imbedding technique is also used to arrive at the independent differential equations satisfied by sequent product densities that are encountered in more comprehensive description of electromagnetic cascades. (auth)

1063 CORRELATION FUNCTIONS FOR COHERENT FIELDS. Titulaer, U. M.; Glauber, R. J. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 140: B676-82 (Nov. 8, 1965).

A factorization condition which must be satisfied by the first n correlation functions for the electromagnetic field operators is used to define nth-order coherence. The first-order coherence condition is shown to imply maximum fringe contrast in interference patterns. The mathematical consequences of assuming the condition for maximum fringe contrast are investigated. By considering the correlation functions as scalar products and formulating rigorous inequalities for them, it can be shown that the assumed condition in turn implies factorization of the first-order correlation function. By extending the same methods it is shown that all of the higher order correlation functions factorize into forms similar to those required for full coherence, but differing from them through the inclusion of a sequence of constant numerical factors. These coefficients are shown to furnish a convenient description of the higher-order coherence properties of the field. Their values are presented for some typical examples. A number of inequalities satisfied by the coefficients are derived for the case of fields which possess positive-definite weight functions in the P representation. Some inequalities obeyed by the correlation functions for such fields are derived as well. (auth)

1064 SOME GENERAL FEATURES OF THE BOOTSTRAP THEORY OF OCTET ENHANCEMENT. Dashen, Roger F.; Frautschi, Steven C. (California Inst. of Tech., Pasadena). Phys. Rev., 140: B698-705(Nov. 8, 1965). (CALT-68-44).

Some general features of the boostrap theory of octet enhancement, which can be understood without detailed calculations, are discussed. These features include: (i) the connection of this theory to the vector-mixing theory of symmetry breaking advocated by Sakurai, and to the tadpole theory of Coleman and Glashow; (ii) an understanding of why it is representations of low multiplicity that are dynamically emphasized in symmetry breaking; (iii) a demonstration that the theory remains valid when a number of assumptions made in previous applications are dropped. (auth)

1065 FORWARD SCATTERING AMPLITUDE AND UNIVALENT FUNCTIONS. Khuri, N. N. (Rockefeller Inst., New York); Kinoshita, T. Phys. Rev., 140: B706-20(Nov. 8, 1965).

A function g(E) of energy E which is both analytic and univalent (schlicht) in the upper-half energy plane was constructed previously, starting with the relativistic crossing-symmetric forward scattering amplitude. The univalence of g(E) is exploited to obtain information on the analytic properties of the forward-scattering amplitude. Various inequalities satisfied by g(E) are derived, making use of powerful theorems on univalent functions. In particular, several theorems are established which relate the asymptotic behavior of the phase of g(E) to that of $|g(E)|$ itself. Inequalities for g(E) which may be useful in an experimental test of the consequences of local field theory are also obtained. Those properties of the forward scattering amplitude already proved in axiomatic local field theory are assumed. The only extra assumption used not yet proved in field theory is the physical assumption that the forward scattering amplitude does not become relatively real in the high-energy limit. (auth)

1066 SUM RULES FOR THE AXIAL-VECTOR COUPLING-CONSTANT RENORMALIZATION IN β DECAY. Adler, Stephen L. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 140: B736-47(Nov. 8, 1965).

By starting from the axial-vector current algebra suggested by Gell-Mann and the hypothesis of a partially conserved axial-vector current, a sum rule relating $1 - g_A^{-2}$ to off-mass-shell pion-proton total cross sections is derived. Numerical evaluation gives the theoretical prediction $g_A = 1.24$, in good agreement with experiment. A similar sum rule for pion-pion scattering can be satisfied only if there is a large low-energy I = 0, S-wave pion-pion scattering cross section. Tests, in high-energy neutrino reactions, of an algebra suggested by Gell-Mann for the vector and axial-vector current octets, are suggested. (auth)

1067 TIME DELAY FOR WAVE PACKETS IN NONRELATIVISTIC SCATTERING THEORY WITH INELASTIC CHANNELS PRESENT. Fong, R. (Case Inst. of Tech., Cleveland). Phys. Rev., 140: B762-6(Nov. 8, 1965).

Time delay is considered in nonrelativistic scattering theory with two-particle inelastic channels present. A comparison method is discussed, which in turn leads to a more natural definition based on the classical definition of time delay for inelastic scattering. (auth)

1068 CONSERVATION LAWS IMPLIED BY LORENTZ INVARIANCE AND CONSERVATION OF SPIN. Jordan, Thomas F. (Univ. of Pittsburgh). Phys. Rev., 140: B766-8(Nov. 8, 1965).

For a reaction from any number of particles in the initial state to any (possibly different) number of particles in the final state, it is shown that Lorentz invariance and conservation of total spin imply conservation laws involving the velocities of the individual particles. Conservation of spin is defined as in a definition of SU(6) for quarks. The implied conservation laws are too restrictive for the description of any interesting interaction of the spinning particles. (auth)

1069 NONCOVARIANCE OF THE DIRAC MONOPOLE. Hagen, C. R. (Univ. of Rochester, N. Y.). Phys. Rev., 140: B804-?(Nov. 8, 1965). (UR-875-85).

The equations which express the divergence of the Maxwell field tensor and its dual in terms of the electric and magnetic current densities are used to construct a field theory of the Dirac magnetic monopole. It is shown that such a theory is incompatible with the requirement of Lorentz invariance if the usual number of degrees of freedom of the electromagnetic field is to be preserved. It is further demonstrated by an explicit construction of the generators of spatial rotations that, independent of the question of Lorentz invariance, the usual argument for the quantization of magnetic charge is not consistent with rotational invariance. A soluble field-theoretic model is given which clearly displays the difficulties of Lorentz invariance inherent in any

theory of the Dirac monopole. The mass spectrum of the Maxwell field in this model is shown by direct calculation to be explicitly noncovariant if and only if both the electric and magnetic couplings are nonvanishing. (auth)

1070 SPONTANEOUS BREAKDOWN OF SYMMETRY IN AXIOMATIC THEORY. Streater, R. F. (Imperial Coll., London). Proc. Roy. Soc. (London), Ser. A, 287: 510-18(Sept. 28, 1965).

It is shown that it is possible to prove Goldstone's theorem in a Wightman theory in which there is a conserved current with a meaning for a sharp time and which generates a broken symmetry. It is also shown that for such theories there exist infinitely many positive linear functionals on the algebra of quasi-local operators which are Lorentz invariant and lead to a theory with positive energy (the vacuum functional may be regarded as non-unique). (D.C.W.)

1071 ON STUCKELBERG'S FORMALISM OF A SPIN-2 FIELD. Podzyarei, Y. A.; Stavraki, G. L. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 10: 563-4(May 1965). (In Ukrainian).

Stuckelberg's formalism has been generalized earlier for a higher spin field, specifically for a spin field of $^3/_2$. It was attempted to apply this formalism to a spin field of 2. Using the calculations of one of the authors, Ukr. Fiz. Zh., 10: No. 1(1965), it is shown that the interactions of the field $U_{\mu\nu}$ (operators of the 2-spin formalism) carried a spin of 2, 1 and 0; the $A_{\mu\nu}$ (symmetric tensor) had only a 2 spin, and B_μ vector, only a 1-spin. (TTT)

1072 THE ADEMOLLO-GATTO THEOREM AND SUPERCHARGED PARTICLES. Zakharov, V. I.; Kobzarev, I. Yu. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 2: 261-4(Aug. 1965). (In Russian).

It is shown that the vector constants in strangeness nonconserving decays can be renormalized, if supercharged particles exist. Relations between the constants are obtained for this case. (auth)

1073 REDUCTION OF THE DIRECT PRODUCT OF IRREDUCIBLE REPRESENTATIONS OF THE GROUP SU(3). Perelomov, A. M.; Popov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 2: 294-306(Aug. 1965). (In Russian).

A geometrical method is suggested to obtain the characters of irreducible representations of the group SU(3). A simple geometrical method is developed to reduce the direct product of two irreducible representations of the group SU(3) with respect to irreducible ones. The main results are formulated in paragraph 4 in the form of rules, according to which irreducible representations, contained in the reduction of $D(p_1q_1) \times D(p_2q_2)$, can be found, together with their multiplicities. (auth)

1074 FOUR-FERMION INTERACTIONS AND BARYON MASSES. Zaretskii, D. F.; Ivanter, I. G. Yadern. Fiz., 2: 307-14(Aug. 1965). (In Russian).

An attempt is made to interpret the baryon mass spectrum (for the octet and decimet) with the help of a simple dynamical model. A four-fermion interaction Hamiltonian is considered, corresponding to a scalar and the eighth component of an 8-vector SU(3) representation. The four-fermion interaction is constructed from the currents of the strongly interacting baryons. A connection between the mass splitting of the baryon octet and the corresponding splitting in the decuplet is found in the framework of the considered model. (auth)

1075 THE BROKEN SCHWINGER SYMMETRY W_3. Kancheli, O. V.; Laperishvili, L. V.; Matinyan, S. G. (Inst. of Physics, Academy of Sciences, Georgian SSR). Yadern. Fiz., 2: 315-20(Aug. 1965). (In Russian).

Relations are obtained between the meson-baryon coupling constants and the meson-baryon scattering amplitudes in the framework of the broken $W_3 = SU_1(3) \otimes SU_2(3)$ symmetry suggested by Schwinger. A connection is established between the W_3 and the SU(3)-symmetry, in which the octet is perturbed by a unitary singlet. (auth)

1076 ON A POSSIBLE CONNECTION BETWEEN WEAK AND STRONG INTERACTIONS. Galanin, A. D. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 2: 342-51(Aug. 1965). (In Russian).

The possible enhancement of the four-fermion interaction, appearing if each diagram vertex is replaced by a sum of simple chains of closed loops, is discussed. For scalar (pseudoscalar) couplings the theory is completely equivalent to a Yukawa type meson theory. For vector couplings a meson with a negative norm appears and it follows that the theory holds only for small momenta, far from the pole. Further a parity non-conserving weak interaction is considered and the solution of a nonlinear equation for the vertex part is investigated. It is shown, that if the vertices do not depend on the momenta, this equation has a further nontrivial parity conserving solution. The arguments depend strongly on the possibility of introducing a cutoff factor in the quadratically diverging integrals and in this sense are not completely satisfactory. (auth)

1077 INTERACTIONS OF A SCALAR FIELD WITH THE GRAVITATIONAL FIELD [Thesis]. Cooke, Charles Franklin. Chapel Hill, N. C., Univ. of North Carolina, 1964. 71p.

Cross sections are calculated for the lowest order processes involving the interactions of a scalar field with the gravitational field, and the first-order renormalization of the action used to find these cross sections is studied. The scattering-matrix amplitudes are found formally by the use of a quantum action functional. In lowest order this quantum action may be replaced by the classical action functional describing the corresponding classical field. The renormalization calculation indicates the structure of the correction term which must be added to the classical action as a result of the propagation of gravitational quanta around closed loops. A brief treatment of field theory and the quantization of fields based upon a noncanonical quantization scheme is given. The scattering-matrix elements are derived. Results are given of cross sections for the Møller scattering of two scalar particles by their gravitational interaction, the process analogous to Compton scattering, the creation of scalar particle pairs by graviton-graviton interaction and the annihilation of two scalar particles into a pair of gravitons, and the scattering of gravitons by gravitons. An expansion of the quantum action functional in terms of classical quantities is used to find the corrections to the classical action. The first correction term corresponds to the presence of closed-loop graviton processes, and the structure of this correction is explicitly evaluated in terms of contracted Riemann tensors and their products. (TCO)

1078 SPIN AND PARITY DETERMINATION OF DECAYING FERMION STATES AND AN INVESTIGATION OF COULOMB SCATTERING AMPLITUDES [Thesis]. Fenster, Stanley. Los Angeles, Univ. of California, 1965. 105p.

A method is given for the determination of the spin-parity J^P of a resonance Y* assuming it decays conserving parity into a spinless boson π and a spin $^1/_2$ fermion Λ whose resulting polarization $\vec{P} = \vec{P}_{transverse} + \vec{P}_{longitudinal}$ may be measured. If parity is violated in $Y^* \rightarrow \Lambda + \pi$, J and the decay parameters α, β and γ of Lee and Yang may be determined. Equations for determining the density matrix of a Y*K* state from the decay distribution in $Y^* \rightarrow \Lambda + \pi$, $K^* \rightarrow K + \pi$ are given. By expressing the density matrix in terms of the Bohr amplitudes for the production process $\pi + p \rightarrow Y^* + K^*$ it is shown that the Bohr amplitudes may all be determined except for a single phase. A study of Regge pole trajectories for the Schroedinger, Klein-Gordon, and Dirac equation with potential $V = -e^2/r$ is presented. The bound state energy levels are correctly given by the crossings of Regge trajectories with lines l = non-negative integer. The trajectories are labeled by the radial quantum number n_r. In the nonrelativistic case the Regge poles are the only singularities of the S matrix considered as a function of energy

and angular momentum; they approach the negative integers $l = -n_r - 1$ as $E \to \infty$. In the relativistic cases an energy-independent branch cut appears in the l plane on the segment $-\frac{1}{2} - e^2 < l < -\frac{1}{2} + e^2$. It is attributed to the singularity of the equivalent potential at the origin. Watson-Sommerfeld integral representations for the three scattering amplitudes are given. (TCO)

1079 REGGE POLES AND THE SEMICLASSICAL APPROXIMATION [Thesis]. Kaufman, Alfred Michael. Waltham, Mass., Brandeis Univ., 1964. 110p.

The behavior of Regge poles in the semiclassical limit is investigated by means of a general WKB approximation. It can be shown that the condition for Regge poles is a Bohr-Sommerfeld quantization of a certain integral taken between turning points in the complex plane of the radial variable. The Bohr-Sommerfeld condition is used to calculate Regge trajectories in the nonrelativistic high energy limit of potential scattering and in the presence of a barrier. The semiclassical replacement of the sum over phase shifts by an integral is investigated. Conditions under which such a replacement can be made correspond to smooth behavior of the phase shift and deflection function. The semiclassical phenomena of interference, rainbow scattering, glory, and orbiting are discussed. (TCO)

1080 THE POSSIBILITY OF FURTHER DEVELOPMENT OF A JOINT COORDINATE-MOMENTUM REPRESENTATION OF QUANTUM MECHANICS. Tyapkin, A. A. pp 199-206 of Philosophical Problems of Elementary Particles Physics. New York, Daniel Davey and Co., Inc., 1965.

It is conjectured that further development of the theory of quantum phenomena will consist of the establishment of those peculiarities of motion of micro-objects in space and time under definite macroscopic conditions as are inaccessible to direct observation, and the starting point should be the proof that it is possible to describe statistically the motion before interaction with the measuring instrument. The necessity of combining the information provided separately by quantum mechanics for the coordinates and momenta of a particle and verified in mutually exclusive incomparable measurements is pointed out. It is further pointed out that the appearance of negative values for the probability density function which describes the joint distribution on noncommuting observables is an indication that some specific peculiarities of quantum physics were not taken into account in the construction on the statistical description. Some of these peculiarities are clarified, and it is shown that a positive distribution function in a joint coordinate-momentum representation may be obtained on the basis of analysis of the case of the interference of two states. (L.B.S.)

1081 THE VACUUM REGGE TRAJECTORY IN SCALAR-VECTOR FIELD THEORY [Thesis]. Sullivan, Jeremiah David. Princeton, N. J., Princeton Univ., 1964. 130p.

Two-particle scattering amplitudes are examined in perturbation theory in the annihilation channel of a model of neutral vector mesons interacting with charged scalar mesons. It is shown that the asymptotic behavior for large values of $\cos\theta$ is determined by a vacuum Regge pole. The lowest order (g^4) contribution to the trajectory of this pole is calculated, and its properties are compared with those of the Pomeranchuk trajectory which has been conjectured to explain the behavior of elastic scattering cross sections at high energies. (Dissertation Abstr.)

Fluid Physics and Thermodynamics

See also Plasma Physics and Thermonuclear Processes

1082 (COO-720-053) PAIR CORRELATION FUNCTIONS IN CLASSICAL STATISTICAL MECHANICS. Blood, Frank Alden Jr. (Case Inst. of Tech., Cleveland, Ohio. Nuclear Physics Lab.). Nov. 1965. Contract AT(11-1)-720. 146p. Dep. mn; CFSTI $4.00 cy, $1.00 mn.

Properties of the pair correlation function for a classical fluid, in equilibrium, having a symmetric potential, are investigated. It is shown that the 3-particle density function for the fluid can be expressed in terms of the pair correlation function. The ideas of the hypernetted chain theory can be used to express the potential as an explicit, although very complicated, functional of the radial distribution function. An approximation of this equation, together with another equation from the hypernetted chain theory, gives the Percus-Yevick equation. The possibility of solving for the pair potential when given the pair correlation function is investigated for seven cases. (auth)

1083 (MATT-368) CONVERGENCE OF ITERATION BASED ON PRIGOGINE'S GENERALIZED VARIATIONAL PRINCIPLE. Kruskal, M. (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1965. Contract AT(30-1)-1238. 8p. (CONF-650562-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Conference on Non-Equilibrium Thermodynamics, Chicago.

The local potential or generalized entropy production integral $\Phi(T,T_0) \equiv \frac{1}{2}\int d\mathbf{V}\lambda(T_0)T_0^2[\nabla T^{-1}]^2$ associated with steady-state heat equation $\nabla \cdot [\lambda(T)\nabla T] = 0$ is examined. An iteration procedure possibly converging to the solution of the second equation is proposed. An investigation of the convergence of this iteration in the simplest possible case is presented. (M.O.W.)

1084 (SU-247-9) FLOW TRANSITION PHENOMENA IN A SUBSONIC PLASMA JET. Incropera, F. P. (Stanford Univ., Calif. Nuclear Technology Lab.). Aug. 1965. Contract AT(04-3)-247. 72p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Flow regimes in a subsonic, argon plasma jet are compared to those which occur in boundary layer separation over a rearward facing step. Measurements of the jet acoustic power and mixing length, as well as visual and photographic studies, verify the existence of laminar, transitional, and turbulent regimes. The conditions under which these flow regimes may exist are specified according to the Reynolds number based on the nozzle diameter and bulk fluid properties, N_{Re}. The plasma jet mode of operation is laminar for $N_{Re} < 110$ to 250, transitional in the range $110 \text{ to } 250 < N_{Re} < 300 \text{ to } 800$, and turbulent for $N_{Re} > 300 \text{ to } 800$. A Reynolds number based on gas properties at the wall of the nozzle reveals that transition from a laminar to a transitional jet occurs at approximately the same Reynolds number as transition from laminar to turbulent flow for conventional fluids in a circular duct. This observation suggests that the principal source of turbulence in the plasma jet stems from turbulence generation at the nozzle walls. Experimental data are presented for nozzles of four different diameters ranging from 0.187 to 0.500 inch and for argon flow rates ranging from 0.02 to 0.300 lb/min. (auth)

1085 THE EFFECT OF ELECTRICAL FIELDS ON THE TRANSPORT PHENOMENA IN GASES. Senftleben, Hermann. Ann. Physik (7), 15: 273-7(1965). (In German).

Within the framework of studies on the effect of external fields on transport phenomena in gases, the detection of electric field effects, analogous to those for magnetic fields, was lacking. Studies were described from which it was shown that the heat conductivity of dipolar gases was affected by external electric fields and that the regularities agree with those found in the study of the effect of magnetic fields on paramagnetic gases. In both cases it is a question of the modification of the mean free path. (tr-auth)

1086 THE BEHAVIOR OF ELECTRONS IN A STRATIFIED LOW-PRESSURE DISCHARGE. Drost, H.; Klotz, H.-D.; Behlke, H.; Pupke, H. (Institut fuer Biophysik, Deutsche Akademie der Wissenschaften, Berlin). Ann. Physik (7), 15: 303-12(1965). (In German).

In the lateral charge carrier extraction along the striated column of a low-pressure discharge in oxygen and argon,

the electrons show—analogous to the behavior of the negative ions—a periodic current pattern that is in close relation to the visually observed column stratification. The oxygen-specific splitting of the ionization current maxima was regarded as further proof of the existence of double strata in oxygen. The probe measurements made along the column plasma detected behavior of the plasma parameter dependent on the stratification (density and temperature of the plasma electrons and velocity of the primary electrons). A qualitative evaluation of the extraction curves obtained was made. A quantitative evaluation of the parametric values made possible a discussion of the formation process of negative ions and therefore a comprehension of the current path along the discharge of drawn-off negative ions. (tr-auth)

1087 HOLLOW-CATHODE EFFECT IN CESIUM VAPOR. Badareu, E.; Popovici, C.; Iova, I.; Somesan, M. (Inst. of Physics, Bucharest). Ann. Physik (7), 15: 313-20(1965). (In German).

The processes in a hollow cathode discharge in Cs vapor were described as they were derived from the electrical and spectral measurements made in a special device. From the electrical measurements, i = f(p), I = f(a), and V = f(a), where i = current intensity, V = voltage, p = vapor pressure, a = distance between the two plates that form the hollow cathode. From the spectral measurements, for the excitation and ionization processes I = f(p) and I = f(i), where I = intensity of the spectral lines. The following conclusions were drawn from the experimental results. A very highly ionized plasma arises between the cathode plates in the hollow cathode effect in Cs vapor. The two completely different areas that can be observed in the negative glow discharge represent two energy-different groups that affect the excitations through direct particle collisions. The contribution of the stage collisions or cascade transitions to the population processes of the Cs 11 levels does not appear to be significant. (tr-auth)

1088 THE ANODE REGION OF A DELAYED GLOW DISCHARGE IN OXYGEN. Drost, H.; Timm, U.; Behlke, H.; Pupke, H. (Institut fuer Biophysik, Deutsche Akademie der Wissenschaften, Berlin). Ann. Physik (7), 15: 294-302(1965). (In German).

The anode region of a delayed glow discharge in oxygen was investigated with respect to the behavior of the plasma potentials. The delay occurred through a compressed electrode built in before the anode in the plasma and the measurement of the space potentials was done by the Langmuir probe method. The auxiliary electrode affects the formation of a pulsed or beam discharge pattern before the anode, which proceeded with a sharp decay of the space potential. The form and size of the discharge parameters were investigated in dependence on the electrode potential and the results were discussed in relation with the anode decay theory of Klarfeld and Neretina. (tr-auth)

1089 CELL MODEL FOR QUANTUM FLUIDS. III. COMPRESSIONAL WAVES IN LIQUID HYDROGEN. Chen, Ru-yong (Univ. of Waterloo, Ont.); Henderson, D.; Reed, R. D. Australian J. Chem., 18: 1309-16(Sept. 1965).

The velocity of sound was calculated for each of the isotopic forms of liquid hydrogen using the quantum cell model. The velocity of sound increased as the pressure increased and decreased as the temperature increased. Also the reduced velocity of sound decreased as the value of the quantum parameter, Λ^*, increased. In addition, the thermodynamic properties of liquid hydrogen compressed by a shock wave were calculated. (auth)

1090 TRANSPORT PROCESSES IN A MULTI-COMPONENT ASSEMBLY ON THE BASIS OF GENERALIZED BGK COLLISION MODEL. Devanathan, C.; Uberoi, C.; Bhatnagar, P. L. (Indian Inst. of Science, Bangalore). J. Indian Inst. Sci., 47: 106-32(July 1965).

Bhatnagar, Gross, and Krook developed a collision model for one-component neutral assembly of particles in order to overcome the inherent difficulties of the Boltzmann collision integral. This was generalized to an N-component assembly of charged and neutral particles by Bhatnagar and Devanathan. However, the transport equations obtained directly from these kinetic equations were far from simple. Transport equations were obtained by expanding the distribution functions in generalized Hermite polynomials following Grad. From these generalized coefficients of direct electrical conductivity, diffusivity, viscosity, and heat conductivity were obtained in the presence of magnetic field. The relaxation times were also calculated. These led to a mechanism of the occurrence of Gross gaps. (auth)

1091 HYDROMAGNETIC SIMPLE WAVE FLOW IN NONUNIFORM DUCTS. [PART] II. Gundersen, Roy M. (Univ. of Wisconsin-Milwaukee). J. Math. Anal. Appl., 11: 28-43(July 1965).

The equations governing the quasi-one-dimensional unsteady motion of an ideal, inviscid, perfectly conducting compressible fluid, subjected to an oblique magnetic field, are linearized in the neighborhood of a known simple wave flow, and weakly nonisentropic perturbations are considered. The perturbations superposed on simple wave flow in nonuniform ducts may then be determined by quadratures. Because of the arbitrary orientation of the magnetic field, both slow and fast simple waves may be considered. Previous work on the case of a transverse magnetic field and the nonmagnetic case is contained as a special case of the analysis. (auth)

1092 PROPAGATION OF HYDROMAGNETIC SHOCKS. Kaul, C. N. (Indian Inst. of Tech., Kharagpur). J. Math. Anal. Appl., 11: 482-7(July 1965).

The propagation of a strong wave-type discontinuity in a conducting incompressible fluid is studied. The conditions under which the propagation of a hydromagnetic shock can be considered as that of a strong Alfvén wave are obtained. (D.C.W.)

1093 THE STATIONARY MAGNETOHYDRODYNAMIC FLOW PROBLEM. Foerste, J. (Institut fuer Angewandte Mathematik und Mechanik, Deutsche Akademie der Wissenschaften, Berlin). Monatsber. Deut. Akad. Wiss. Berlin, 7: 1-6(1965). (In German).

The principle of existence for the magnetohydrodynamic basic equation is derived and the proof of the existence principle is given. (J.S.R.)

1094 INSTABILITIES AND GROWING WAVES. Rolland, P. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev., 140: B776-87(Nov. 8, 1965).

The character, stable or unstable, of a medium can be deduced from the behavior of an ideal model of a semi-infinite medium which is subjected to an excitation only at the boundary. A new analytic method is used to solve this particular problem. The results obtained show a connection between the character of the medium and certain properties of the dispersion equation and agree with those derived from other methods by Sturrock, Jackson, Bers, and Briggs. (auth)

1095 ON THE PRODUCTION OF SHORT SINGLE PULSES IN HIGH-CURRENT DISCHARGES. Brinkschulte, Hermann; Muntenbruch, Helmut (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Angew. Physik., 19: 227-33(1965). (In German).

Various arrangements which can be used for the production of single impulses of high-current density and great steepness were theoretically investigated. Aperiodic damp discharges were compared with those in the crowbar and the power crowbar systems. The latter was clearly superior to the former. The influence of deviations of the individual current circuit parameters from the ideal values was also discussed. Measurements on a power crowbar apparatus conceived after the results obtained confirm the validity of the superiority. (tr-auth)

Geophysics

1096 A TEMPERATURE CURVE FOR THE UPPER ATMOSPHERE FROM 80 TO 160 KM BASED ON 3 914 A

N_2^+ ROTATIONAL TEMPERATURES IN AURORA. Brandy, J. H. (Defence Research Northern Lab., Fort Churchill, Manitoba). Can. J. Phys., 43: 1697-1700(Oct. 1965).

Rotational temperatures derived from the 3 914-Å N_2^+ band in aurora along with simultaneous height measurements were obtained in 1964 and 1965 for 75 points. The heights range from 82.5 to 161.5 km and, from the average curve plotted, the gradient above about 95 km is 4.9°/km. Above that height the plot appears to be linear. Large differences in temperature from the average are thought to be considerably in excess of the maximum error expected and may indicate variations in temperature in this zone for any given height. (auth)

1097 AURORAL HEIGHTS OVER CHURCHILL, MANITOBA, DURING INTERNATIONAL QUIET SOLAR YEAR. Hill, J. E. (Defence Research Northern Lab., Fort Churchill, Manitoba). Can. J. Phys., 43: 1917-19 (Oct. 1965).

The heights of the lower borders of 1,197 auroras were determined during 1964 and 1965. A plot of the heights vs frequency of occurrence resulted in peaks at 110 and 120 km. While only 9.86% of all the auroras measured occurred between 100 and 107 km, 21.55% occurred between 108 and 115 km and 17.2% occurred between 116 and 123 km, remarkably higher than when sunspot activity was at a maximum. (D.C.W.)

1098 SOLAR WIND AND ITS INTERACTION WITH THE MAGNETOSPHERE. Sonett, Charles P. (Ames Research Center, Moffett Field, Calif.). J. Res., Nat. Bur. Stand., D, 69D: 1033-41(Aug. 1965).

A short summary of the properties of the solar wind, as they apply to the interaction process with the earth's magnetosphere, is given. Necessary conditions on the bow shock are discussed and are compared to experimental evidence from several space probes. The importance of the downstream or post-shock flow is emphasized. Power spectra and details of the turbulence in this region are reviewed. Limitations due to the very preliminary status of IMP data analysis are emphasized. (auth)

1099 EXPERIMENTAL RESULTS ON THE DYNAMICS OF THE F REGION. Becker, W.; Ruester, R.; Klostermeyer, J. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.). J. Res., Nat. Bur. Stand., D, 69D: 1083-7(Aug. 1965).

The response of the nighttime ionosphere to variations of the earth's magnetic field, especially to variations of its horizontal component, is considered first. It is shown both theoretically and experimentally that the whole F region is set in motion by such variations of the earth's magnetic field and that these motions may be of an oscillatory or a nonoscillatory character. Amplitudes in real height of 75 and 200 km respectively are reported. Other kinds of u-l-f oscillatory movement of the F region during magnetically quiet winter nights of which some last for at least 10 hr are then treated. A 3-station network of identical ionosondes allows interpretation of them as traveling waves propagating mostly southward and only occasionally northward. Their phase velocities cover the range 15 to 35 km/min and the respective periods of duration lie between 2.8 and 1.5 hr. Missing ionograms of the field stations prevented phase velocity calculations for a 0.7 hr wave. The amplitudes of all the waves covered the range between 10 and 15 km. Traveling waves of longer and shorter wavelengths may be possible but could not be detected because of experimental reasons. It is believed that these traveling waves represent internal gravity waves as suggested by Hines. (auth)

1100 PROPAGATION OF HYDROMAGNETIC WAVES IN THE MAGNETOSPHERE. Sugiura, Masahisa (Goddard Space Flight Center, Greenbelt, Md.). J. Res., Nat. Bur. Stand., D, 69D: 1133-47(Aug. 1965).

Characteristics of waves in a two-component cold plasma are reviewed. Using the Clemmow-Mullaly-Allis diagram, the topological types of the wave-normal surfaces are shown. A consistent system of labeling the modes, initially given by Allis, is explained. Reversal in the polarization in the electric field is examined, and all the modes in which the reversal occurs are specified. There is no polarization reversal in u-l-f to v-l-f waves in the magnetosphere. The lower hybrid resonance frequency in the magnetosphere is discussed. The equations of motion for an electromagnetic ray are derived. Defining the action for the ray with analogy to that for a particle in classical mechanics, the principle of least action is proved. It is shown that if the dispersion relation is homogeneous in the wave vector and the frequency, the principle of least action implies the principle of least time, i.e., Fermat's principle. When the principle of least time holds, as in the case with Alfvén compressional waves, the trajectory of a ray can be determined from a variational equation, from which the problem can be formulated in Hamiltonian form. For the axially symmetric case, the generalized momentum conjugate to the azimuthal coordinate is a constant of motion. Using this relation, "allowed" and "forbidden" regions are defined when a set of initial conditions for the ray is given. This method is applied to a model magnetosphere with a dipole magnetic field. It is shown that the accessibility of hydromagnetic rays originating from the boundary of the magnetosphere to the earth is greatly limited. For a distorted magnetosphere the canonical equations for a hydromagnetic ray are integrated by a numerical method. Typical trajectories in the equatorial plane are shown, and the effects of the deformation of the dipole field on the ray trajectories are discussed. (auth)

1101 IONOSPHERIC PERTURBATION (THE ROLES PLAYED BY THE IONOSPHERE IN GEOMAGNETIC PULSATIONS). Matsushita, S. (National Center for Atmospheric Research, Boulder, Colo.). J. Res., Nat. Bur. Stand., D, 69D: 1149-59(Aug. 1965).

Possible roles played by the ionosphere in geomagnetic pulsations are reviewed. First, relations between the quiet ionosphere and regular pulsations are discussed from the viewpoint of hydromagnetic wave propagation and ionospheric currents. Ionopheric variations and correlated irregular pulsations during disturbances and storms are then discussed. These phenomena sometimes occur in correlated form during solar flares, sudden commencements and impulses, bays, DS variations, and polar elementary storms. The main causes seem to be solar electromagnetic radiations, hydromagnetic waves, incoming particles, and resultant ionospheric currents. Ionospheric and micropulsation phenomena caused by nuclear explosions and meteors are very briefly reviewed. Emphasis is given to the type of work in this field which needs to be done in the future. (auth)

1102 INTERPRETATION OF EARLY MAGNETIC TRANSIENTS CAUSED BY HIGH-ALTITUDE NUCLEAR DETONATIONS. Kahalas, S. L. (Mt. Auburn Research Associates, Inc., Cambridge, Mass.); Newman, P. J. Res., Nat. Bur. Stand., D, 69D: 1179-83(Aug. 1965).

A high-altitude nuclear detonation produces magnetic disturbances which propagate to points remote from the detonation area. The worldwide magnetic disturbances occurring within a few seconds after the detonation are discussed. Data from Starfish are presented to show the general characteristics of the early-time magnetic field behavior. Various interpretations of these results are discussed. In particular, there is a signal occurring within a few tenths of a second after the detonation. This is interpreted to be the conventional electromagnetic pulse produced by asymmetric absorption of gamma rays in the lower atmosphere. The pulse propagates to far distances in the earth-ionosphere cavity. In addition, worldwide data show a second signal occurring within 1.5 to 2 sec after the Starfish detonation. This is also interpreted as an electromagnetic wave propagating in the earth-ionosphere cavity. It is generated by a bomb-induced magnetohydrodynamic wave which propagates downward from the vicinity of the detonation and is converted to electromagnetic form at the lower boundary of the ionosphere. (auth)

1103 ANNOTATED BIBLIOGRAPHY ON THE IONOSPHERE. Samuel, Parkash. Meteorol. Geoastrophys. Abstr., 15: 2479-2580(Dec. 1964).

A special bibliography is presented on the ionosphere. It consists of theoretical and experimental works published in 1960 and thereafter, and is a continuation of the 7 bibliographies previously published. A number of papers presented at conferences listed are included in the compilation. The material is arranged alphabetically by author. Subject and geographic outlines are provided to indicate specific aspects of the subject and the places where the studies were made. (J.F.P.)

1104 TABLES AND MAPS OF GEOMAGNETIC COORDINATES CORRECTED BY THE HIGHER ORDER SPHERICAL HARMONIC TERMS. Hakura, Yukio (Radio Research Labs., Kokubunji, Tokyo). Rept. Ionosphere Space Res. Japan, 19: 121-57(1965).

A new coordinate system useful for quantitative analysis of geophysical phenomena is presented. The corrected geomagnetic coordinates are calculated by the use of Hultqvist's perturbation vectors which give the displacement of the "landing points" of the geomagnetic field lines, due to the four spherical harmonic terms following the dipole term. Tables give the corrected geomagnetic coordinates for 2486 points both in the northern and southern hemispheres, through which the corrected coordinates for any point in the higher latitude zones on the earth's surface can be obtained. Other tables give the corrected coordinates of the principal geophysical observatories: 120 ionospheric vertical sounding stations, 52 VLF and whistler stations, 162 geomagnetic stations, 61 auroral stations, and 31 cosmic ray observing stations. Several world maps and charts are presented with some examples in order to afford facilities to the users of the tables for their statistical analysis of various geophysical phenomena. Times in the corrected geomagnetic coordinates are also defined. (auth)

1105 GEOMAGNETIC PULSATION pc-5 IN AND NEAR THE AURORAL ZONES. Kokubun, Susumu; Nagata, Takesi (Tokyo Univ.). Rept. Ionosphere Space Res. Japan, 19: 158-76(1965).

Geomagnetic pulsation pc-5 with a period of several minutes is discussed, based on data collected during the IGY period. One of the interesting characteristics of pc-5 found in this study is that the sense of rotation of the disturbance vector in the horizontal plane is counter-clockwise in the morning, and clockwise in the afternoon in the northern auroral zone, and that the situation is reversed in the southern auroral zone. This local-time dependence of change in polarization is just the same as that for sudden commencements of magnetic storms. The amplitude of the morning type pc-5 with counter-clockwise polarity in the northern auroral zone is found to be generally larger than that of the afternoon one. It is suggested that the characteristic difference between the morning and afternoon pc-5 is attributable to the difference in propagation modes of hydromagnetic waves; namely, the morning pc-5 corresponds to the Alfven mode, and the afternoon pc-5 to the isotropic mode. (auth)

1106 DYNAMIC BEHAVIOUR AND NORTH-SOUTH CONJUGACY OF GEOMAGNETIC BAYS. Kokubun, Susumu (Tokyo Univ.). Rept. Ionosphere Space Res. Japan, 19: 177-200(1965).

The progressive change in world-wide current-systems and auroral zone electrojets of geomagnetic bays is examined with the aid of magnetic data collected during IGY. It is shown that the eastward electrojet appearing in the evening does not develop at the same time as the westward electrojet which appears after midnight, and that the latitudinal movements of the eastward and westward electrojets are predominately equatorward and poleward, respectively. Current-systems of individual geomagnetic bays have considerable similarity in both the northern and southern hemispheres. At the geomagnetically conjugate points, Syowa Base and Reykjavik, in the auroral zones, negative bays show better conjugacy than positive bays. (auth)

1107 STORM SUDDEN COMMENCEMENTS AS SOLAR BLAST WAVES. Nishida, Atsuhiro (Tokyo Univ.). Rept. Ionosphere Space Res. Japan, 19: 201-13(1965).

As a measure of the magnitude of a solar blast wave which causes a storm sudden commencement, the transmission speed of the blast wave relative to the moving medium of the solar wind is derived, using the relation between the wind speed and Kp obtained from Mariner II observations. The wave speed thus derived is compared with the characteristic parameters of the relevant solar flare, and is found to be roughly proportional to the square root of the total flux of the type IV-m burst accompanying the flare. It is deduced that energies of the blast wave and of the type IV-m burst are approximately proportional to each other. This result is explained in terms of the synchrotron radiation theory for a type IV-m burst. (auth)

1108 SUMMARY OF DAILY OBSERVATIONAL RESULTS OF SOLAR PHENOMENA, COSMIC RAY, GEOMAGNETIC VARIATION, IONOSPHERE, RADIO WAVE PROPAGATION AND AIRGLOW DURING JULY THROUGH DECEMBER 1964. Rept. Ionosphere Space Res. Japan, 19: 233-42(1965).

A summary of daily observational results of solar phenomena, cosmic ray, geomagnetic variation, ionosphere, radio wave propagation and airglow observed in Japan is presented. The observational results are arranged by the solar rotation number. The illustrations do not show all observational results in Japan, but only representative ones at some key stations. Data during July through December, 1964, are presented. (J.F.P.)

1109 LUNAR TIDAL OSCILLATIONS IN H AND f_0F_2 AT EQUATORIAL STATIONS. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Z. Geophys., 31: 27-40(1965).

Lunar tidal, L_2, oscillations in the solar diurnal range of the horizontal component of earth's magnetic field, H, and in the midday value of the critical frequency of the F_2 region of the ionosphere, f_0F_2, at the low latitude stations operating in Peru during IGY and IGC are described. During any of the seasons, the amplitude of L_2 oscillations in the range of H as well and in f_0F_2 show a maximum over the magnetic equator similar to that of the range of H itself. At any of the stations, L_2, oscillation in the two parameters are almost opposite in phase. The results of L_2 oscillations in the range of H at Huancayo (Bartels and Johnston (1940)) for the period 1922–1938 are compared with the results of similar analysis of midday value of f_0F_2 at Huancayo for the period 1938–1960. The seasonal variations of the amplitude of L_2 oscillation in either of the parameters are very similar to each other with the maximum during January and the minimum during June/July. The phase of L_2 oscillation in the two parameters varies sympathetically with the month of the year, maintaining almost anti-phase relationship. With increasing solar activity the amplitudes of L_2 oscillations in both parameters seem to increase but the phase remains constant. Comparing the L_2 oscillations in H and f_0F_2 for individual hours of the solar day, the amplitudes are found to be strong during the daylight hours with a maximum near noon. Again for any time of the day, L_2 oscillations in H and f_0F_2 are opposite in phase. It is concluded that near the magnetic equator the lunar tidal oscillations in the F_2 region of the ionosphere are closely associated with the lunar variation in the strength of the equatorial electrojet. (auth)

Gravitation, Quantum Mechanics, and Relativity Theory

1110 (JINR-P-2306) PRUPPOVYE SVOISTVA I INVARIANTNAYA FORMA URAVNENIYA SHREDINGERA. (Group-Theoretical Properties and Invariant Form of the Schroedinger Equation). Smorodinskii, Ya. A.; Tugov, I. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 10p. Dep. mn.

The group of point transformations of the Schrödinger equation is geometrized for any number of independent

variables $n \geq 2$. It is shown that the system of equations determining the Lie algebra of the group of the Schrödinger equation reduces to the Killing equations for a certain Riemann space. (auth)

1111 NOTES ON THE SCHROEDINGER OPERATOR. Ryan, Robert (Univ. of Wisconsin, Madison). J. Math. Anal. Appl., 11: 410-21(July 1965).

The properties of the spectrum and resolvent of Schroedinger operators $-\Delta + q(x)$ in 3-dimensional Euclidean space are studied. It is assumed that q is locally square integrable and $O(|x|^{-1-\epsilon})$ as $|x| \to \infty$ ($\epsilon > 0$). (auth)

1112 AN EXACT MASTER-EQUATION WITHOUT RANDOM PHASES IN THE INITIAL STATE. Stahl, A. (Technische Hochschule, Aachen). Phys. Lett., 19: 213-14(Oct. 15, 1965).

It is shown that an exact master equation can be obtained which is valid even if the initial density operator is not diagonal in the representation in which the master equation is formulated. (D.C.W.)

1113 UNSTABLE BOUND STATES OF THE SCHROEDINGER EQUATION. Sannikov, S. S. (Physico-technical Inst., Kharkov). Phys. Lett., 19: 216-17(Oct. 15, 1965).

It is shown that the Schroedinger equation with an attractive potential has a class of solutions corresponding to unstable bound states. (D.C.W.)

1114 EFFECT OF GRAVITY ON GAMMA RADIATION. Pound, R. V.; Snider, J. L. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 140: B788-803(Nov. 8, 1965).

Recoil-free resonant absorption of the 14.4-kev γ ray in ^{57}Fe was employed to measure the effect of gravity over a 75-ft vertical path, in an improved version of the experiment of Pound and Rebka. A ^{57}Co source, initially 1.25 C, large-windowed proportional counters, and an enriched absorber foil 15 in. in diameter permitted a much increased counting rate. The employment of temperature-regulated ovens for source and absorbers and a redesigned monitor system to detect variations in waveform of the source velocity effected a reduction in systematic uncertainties. The result found was (0.9990 ± 0.0076) times the value 4.905×10^{-15} of $2gh/c^2$ predicted from the principle of equivalence. The range given is the statistical standard deviation set by the number of counts involved. An estimated limit of systematic error is 0.010. (auth)

1115 INTERACTIONS OF THE GRAVITATIONAL FIELD WITH A GENERALIZED YANG-MILLS FIELD [Thesis]. Dotson, Allen Clark. Chapel Hill, N. C., Univ. of North Carolina, 1964. 62p.

Quantum field theory is applied to the interaction between gravitational and generalized Yang-Mills fields. The dynamics are based on the principle of least action. The generalized Yang-Mills group is combined with the invariance group of general relativity, and the theory is required to be invariant under the combination. The derivation of the S-matrix amplitudes in the linearized version of the general theory is discussed. The results are applied to (1) Yang-Mills field self-scattering by way of an intermediate graviton, (2) single-graviton production, (3) double-graviton production, and (4) Compton-type scattering of Yang-Mills quanta by gravitons. In each process, the magnitude by which the total spin can change during the interaction is found to be restricted to the minimum possibility—zero for processes (1), (3), and (4), and unity for case (2). The scattering cross sections in the center-of-momentum system are computed. A discussion is given of the infinite renormalization terms which must be added to the classical action to keep the quantum theory meaningful when the contributions of higher-order interactions are included. Approximate expressions for the Feynman Green's functions for the combined fields and for the combined invariance group are calculated. These results lead to the terms needed to renormalize the action. (TCO)

1116 PART I: HYPOTHETICAL BASES OF THE GENERAL THEORY OF RELATIVITY. PART II: STABILITY OF RELATIVISTIC ORBITS [Thesis]. El-Abd, Abd El-Hamid Ali. Knoxville, Tenn., Univ. of Tennessee, 1964. 63p.

The principle of covariance in general relativity must be used to obtain an action integral invariant under coordinate transformation, in order to derive the equations of motion of a body in a gravitational field. The method of Schiff, using special relativity and the equivalence principle, was modified to obtain all the experimentally verified results of the general theory of relativity, for the case of a centrally symmetric gravitational field: the red-shift, the bending of light, and the precession of the perihelion of a planetary orbit. The stability of an artificial earth satellite was studied by this method. (TCO)

1117 THE VELOCITIES OF 4 Bev/c PIONS AND 8 Bev/c PIONS, KAONS AND PROTONS [Thesis]. Jordan, Lawrence Marcellus. Princeton, N. J., Princeton Univ., 1964. 129p.

The relation between the momentum of an elementary particle and its velocity can be used to test various theories of relativity. Measurements of corresponding momenta and velocities of fast elementary particles are reported. A standard deflecting magnet was employed in the momentum measurements, and a constant-angle differential gas Cherenkov counter, to which a special refractivity measuring interferometer was attached, was used to determine the velocities. The principal results are given for electrons, pions, K mesons, and protons. Einstein's standard relativity is found to be consistent with these findings, whereas a relativistic theory incorporating a zero mass tensor field proposed by Peebles and Dicke (Phys. Rev., 127: 629(1962)) is found to be inconsistent by a factor of 5 times the experimental uncertainty. (TCO)

Low Temperature Physics

Refer also to abstracts 1264 and 1265.

1118 (COO–1198-302) EXPERIMENTAL PROPERTIES OF LIQUID ^3He AT VERY LOW TEMPERATURES. Wheatley, J. C. (Illinois Univ., Urbana. Dept. of Physics; Illinois Univ., Urbana. Materials Research Lab.). [1965]. Contract AT(11-1)-1198. 64p. (CONF-650822-1). Dep. mn; CFSTI $3.00 cy, $0.75 mn.

From International Conference on Quantum Liquids, Brighton, Sussex, Eng.

An experimental investigation of liquid ^3He at low temperatures is presented. A brief description of the experimental apparatus is given. The results are interpreted in terms of Landau's theory of Fermi liquids. In addition, measurements oriented toward a search for superfluidity in ^3He are also discussed. Finally, a brief review is given of those experiments which bear on the region of temperatures above that for which the characteristic temperature dependences of the Fermi liquid are observed for most parameters. (M.O.W.)

1119 (LA-DC-7357) NARROW CHANNEL FLOW. Hammel, E. F.; Keller, W. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 38p. (CONF-650824-1). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Symposium on Liquid Helium, St. Andrews, Scotland.

Studies were made of the flow of liquid helium II through narrow slits. The studies included heat flow, critical superfluid velocities under isothermal and heat flow conditions, mutual friction forces in isothermal flow, ∇P vs $\vec{V}_s$ relationships in gravitational flow, and dissipative flows. Some unanswered questions regarding narrow channel flow are posed. (D.L.C.)

1120 (ORNL–3836, pp 90-110) MAGNETICS AND SUPERCONDUCTIVITY. (Oak Ridge National Lab., Tenn.).

For the design of conventional and superconducting magnet coils, it is important to find the coil parameters that

yield the highest field efficiency (expressed by the Fabray factor G) if the coil volume factor v is known. Graphs are presented that are useful for magnet-coil design work. The development of micro Hall probes using the III-V semiconducting compounds indium antimonide and indium arsenide, which exhibit a large Hall effect, is considered. A device for introducing currents of several hundred amperes into liquid-helium environments is developed. Efficient design can be achieved without liquid-nitrogen cooling by forcing evaporating helium through copper tubing of appropriate length. Investigations of superconducting niobium–zirconium magnet coils show the close relationship between the so-called degradation effect and the flux jump phenomenon. The latter can be studied most easily by using hollow or solid cylinders in longitudinal external fields. A theory for the one-dimensional case is developed that shows the dependence of the critical external field upon the rate of field rise under nearly adiabatic conditions. The influence of the sample radii and of the external-field "history" is considered. It is possible to measure the velocity of the longitudinal propagation of the flux jump and its dependence on the external field. Flux jumps are observed in a test coil wound with 10-mil unplated Nb–25% Zr wire. The flux jump energies are large when the coil self-field and the external field are in opposite directions. With various constant transport-current densities, critical external-field strengths were measured with increasing and with decreasing external fields. An analysis of the magnitude of the resulting fields inside the coil-winding volume shows that flux jumps at field strengths smaller than 5 kilogauss are dangerous. This agrees with magnetization measurements in external fields with varying transport currents. Tests were made with superconducting sample coils of large diameter but with small cross-sectional areas using external fields up to 75 kilogauss. (auth)

1121 (AI-Trans-97) METHOD OF INCREASING THE CRITICAL CURRENT DENSITY OF HARD SUPERCONDUCTING ALLOYS AND THE PRODUCTS THEREOF. Betterton, Jesse Oatman Jr.; Kneip, George Dewey Jr.; Easton, Dewey Sloan; Scarbrough, James O'dell. Translated by J. B. Vetrano (Atomics International, Canoga Park, Calif.) from French Patent 1,371,338. 17p. Dep. mn; JCL $1,60 fs, $0,80 mf.

A method for increasing the critical current density of a hard superconducting alloy is presented. The process consists in mixing into the alloy in the liquid state an additive chosen from the group made up of oxygen, carbon, nitrogen and hydrogen, to homogenize the resulting mixture at a temperature below the melting point of the alloy in order to secure a uniform dispersion of the additive, reheating the resulting homogenized alloy in order to induce the formation of a finely divided, uniformly distributed, precipitate phase containing the additive, and then reducing the diameter of the alloy thus treated to the desired wire diameter. The hard superconducting alloy is formed from metals chosen from any of Groups III, IV, V, VI, VII and VIII, and from Groups IVA, VA and VIA of the periodic table. The initial composition of the alloy comprises a metal chosen from Groups IV, V, VI, VII and VIII of the periodic table. The additive is chosen from among the compounds having the general formula MX, in which M is a metal having an electronegativity index less than the electronegativity index of the metal forming the principal alloy element of the alloy, and X is an oxide, a carbide, a hydride or a nitride of M. The procedure and results from processing a niobium-zirconium alloy are presented. (M.O.W.)

1122 MAGNETOCALORIC EFFECTS AND ENTHALPY IN THE MIXED STATE OF SUPERCONDUCTING NIOBIUM. Wasim, S. M.; Grenier, C. G.; Zebouni, N. H. (Louisiana State Univ., Baton Rouge). Phys. Lett., 19: 165-6(Oct. 15, 1965).

The temperature of a single-crystal rod of Nb was measured during slow magnetic field sweeps ($\dot{H}$ = 5.73 gauss/sec) using a calorimetric arrangement, and magnetization measurements were made using the heat-pulse ballistic method. At temperatures $3.2°K < T < T_c$, pure cooling of the sample occurs in increasing fields, distributed over the mixed state. This phenomenon is reversible upon reversal of $\dot{H}$. At temperatures $1.2°K < T < 3.2°K$, a mixed calorie behavior was observed. The behavior of the entropy and the enthalpy in the mixed state of Nb was determined from the observations. (D.C.W.)

1123 NUCLEATION OF SUPERCONDUCTIVITY IN WEDGE GEOMETRY. Houghton, A.; McLean, F. B. (Brown Univ., Providence). Phys. Lett., 19: 172-4(Oct. 15, 1965).

The nucleation region was studied for samples having infinite wedge geometry. It was shown that superconducting regions do appear first near the point of the wedge and that the nucleation field $H_{c3} \approx (3/2)^{0.5}\kappa H_c/\varphi_0$ as $\varphi_0 \to 0$, where φ_0 is the angular half width of the wedge, κ is the Landau–Ginzburg parameter, and H_c is the bulk critical field. Therefore, it should be possible to measure κ from a determination of H_{c3} in wedge geometry. (D.C.W.)

1124 MICROWAVE OBSERVATION OF PROXIMITY EFFECTS IN MAGNETIC FIELDS. Fischer, G.; Klein, R.; McEvoy, J. P. (Labs. RCA, Ltd., Zurich). Phys. Lett., 19: 193-4(Oct. 15, 1965).

Superconductivity was observed in normal metal films deposited over a flat type-I superconductor. The metal films were electroplated copper of thicknesses d = 1, 2, 3, and 4×10^3 Å; the superconductor was a Pb-0.10% In alloy. The metal film had little effect on the superconductor, but the superconductor exerted a very strong influence on the metal film. (D.C.W.)

1125 VARIABLE HELIUM FILM TRANSFER RATES DOWN TO 0.5°K. Allen, J. F.; Matheson, C. C.; Walker, Cecilia M. (St. Andrews Univ., Scotland). Phys. Lett., 19: 199-200(Oct. 15, 1965).

The variation of both the normal and enhanced flow rates with temperature was studied between 0.49 and 1.2°K. (D.C.W.)

1126 CRITERIA FOR THE BEST BOGOLIUBOV QUASIPARTICLE. Kobe, Donald H. (Uppsala Univ.). Phys. Rev., 140: A825-9(Nov. 1, 1965).

The principle of compensation of dangerous diagrams has previously been the only general criterion for determining the coefficients in the Bogoliubov canonical transformation to quasiparticles. It is shown that the criterion of maximum overlap of the true ground state with the BCS ground state gives the same condition for determining the coefficients. The criterion of diagonalizing the quadratic part of the reaction operator, which is a generalization of the Brillouin-Brueckner condition, is also equivalent to the above criteria. Finally these criteria are evaluated from the standpoint of "least labor for the most accuracy." (auth)

1127 RESONANCE SCATTERING IN IMPURE SUPERCONDUCTORS. Zuckermann, M. J. (Univ. of Chicago). Phys. Rev., 140: A899-905(Nov. 1, 1965).

A model of Anderson's is used to obtain the effect of transition-metal impurities on simple superconductors due to resonance scattering. If it is assumed that the impurities do not sustain a magnetic moment, then a sharp decrease in the critical temperature is found when $kT_c \gg \Gamma \gg E_d$. Here Γ is the broadening of the bound d state on each impurity due to Anderson's s-d interaction and E_d is the energy displacement of the d state from the Fermi level. This region is, in fact, unphysical since the s-d interaction is too small to swamp out the magnetic moment of each impurity. In consequence, the theoretical analysis of Merriam et al. for the In-Mn alloys is incorrect. The decrease in T_c is much weaker when $\Gamma \gg kT_c$. This is the physical region in which the magnetic moments are swamped out by the s-d interaction. It is also shown that the superconducting state in such alloys displays a nonzero energy gap at all impurity concentration. When the s-d interaction is weak the impurity has a nonzero magnetic moment and the problem is shown to reduce to one

already considered by Gor'kov and Rusinov. The results are used to comment on the experimental results of Merriam et al. and of Boato et al. Also, reasonable agreement with Friedel's predictions is found. (auth)

1128 FLUX PENETRATION IN CYLINDRICAL SUPERCONDUCTING FILMS. I. SPATIALLY CONSTANT ORDER PARAMETER. Pincus, P. (Universite de Paris, Orsay, France; Univ. of California, Los Angeles). Phys. Rev., 140: A911-13(Nov. 1, 1965).

The effective penetration depth λ_{eff} in thin cylindrical films [$d < \xi(T), \Lambda(T)$ is calculated where $\xi(T)$ and $\Lambda(T)$ are, respectively, the temperature-dependent coherence length and zero-field penetration depth and d is the film thickness] for rf fields while the film is in an axial static field H close to the tangential critical field H_{II} for a second-order phase transition. It is found that $\lambda_{eff} \approx [\Lambda^2(T)/d][H_{II}^2/(H_{II}^2 - H^2)]$. In addition, it is shown that sizeable harmonic generation for static fields close to H_{II} and for sufficiently thin films may be expected. (auth)

1129 SOLUTE SIZE AND VALENCE EFFECT IN SOME SUPERCONDUCTING ALLOYS OF TRANSITION ELEMENTS. DeSorbo, Warren (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 140: A914-19(Nov. 1, 1965).

The use of the concept of an effective electron-atom ratio, N_{eff}, which contains a solute size correction (rather than the usual ratio N used in Matthias' rule), introduced earlier in correlating superconducting critical temperatures of some dilute solutions of transition elements of the 4th, 5th, and 6th columns in niobium, was extended to include some other transition-metal solutes of columns 7, 8, 9, and 10 in niobium. The concept was also tried on some other transition-metal solid solutions of wider range of composition. For these latter alloys the analysis reveals that peaks in the curve of T_c versus electron-atom ratio occur at $N_{eff} \sim 4.4$ and ~ 6.6, whereas with the uncorrected electron-atom ratio, these peaks tend to occur near $N \sim 4.7$ and ~ 6.4. The variation of H_{c2} with N_{eff} for alloys of transition metals of columns 4 and 5 suggests that the maximum values of H_{c2} also occur near $N_{eff} \approx 4.4$. Both peaks in T_c versus N_{eff} and H_{c2} versus N_{eff} seem to be independent of whether the solvent or solute atom is in the 3d, 4d, 5d series. (auth)

1130 VELOCITY FIELDS OF HELIUM II CARRYING A HEAT CURRENT. Allen, J. F.; Griffiths, D. J.; Osborne, D. V. (Univ. of St. Andrews, Fife). Proc. Roy. Soc. (London), Ser. A, 287: 328-42(Sept. 14, 1965).

The velocity fields of helium II were studied in a short, wide tunnel in which a heat current can be made to flow. A fine quartz fiber suspended from the tunnel roof and carrying a small weight at its lower end is used as a probe. The random motion of the fiber measures the intensity of turbulence in the normal fluid, while its response to short heat pulses, either alone or superimposed on a heat current, is related to the superfluid circulation about the fiber. From the size, direction and rate of change of this circulation the state of vorticity of the superfluid can be deduced. At 1.3°K, three flow regimes are found. In low or zero heat currents the normal-fluid flow is laminar; observed circulations are of the order of one quantum and persist for many seconds. It is believed that they are created by the measurement process (the heat pulse) itself, so that in this regime the superfluid is essentially undisturbed. In the second regime, which occurs above an onset heat current determined by the geometry, the observed circulations are smaller and more variable. It is argued that this results from superfluid vorticity associated with secondary flow. In the third regime random motion of the fiber occurs. It is shown that this motion can not be due to superfluid turbulence alone: the normal fluid must be turbulent, and probably the superfluid also. The regime occurs when a modified Reynolds number, based on the normal-fluid viscosity and mean velocity, the mean tunnel diameter and the total density of the helium, exceeds a critical value of about 1350. The onset of the third regime is the analog for helium II of the classical transition from laminar to turbulent flow. The behavior at higher temperatures is similar but less clear cut. It is concluded that, while the behavior of the measured circulations about the fiber is consistent with the quantization of superfluid circulation, the critical velocities observed in heat currents in wide channels are directly related not to the creation of quantized vortex lines, but to the quasi-classical effects, secondary flow and turbulence. (auth)

1131 THE SUPERCONDUCTING PENETRATION DEPTH IN NIOBIUM [Thesis]. Maxfield, Bruce Wright. New Brunswick, N. J., Rutgers Univ., 1964. 83p.

The change in the resonant frequency as a function of temperature was measured for a tank circuit, the coil of which contained a niobium core, at 4 and 80 mc using variable frequency oscillators. The rate of change of the penetration depth with $y = (1 - t^4)^{-\frac{1}{2}}$ was found (where t is the reduced temperature). Above y = 2, $d\lambda/dy$ does not vary greatly and is about 440Å. As y decreases toward 1, $d\lambda/dy$ increases more than predicted by the BCS theory. The energy gap in the superconductor was determined from the penetration depth. (TCO)

1132 MAGNETIC INSTABILITIES AND FLUX ANNIHILATION IN GROSSLY INHOMOGENEOUS SUPERCONDUCTORS. Blaugher, R. D.; Joiner, W. C. H. (Westinghouse Electric Corp., Baltimore). 15p. (CONF-650653-1). Gmelin, AED-CONF-65-170-12.

From American Physical Society, Summer Meeting, New York.

The field inside a solenoid magnet made from Nb 25% Zr, 10 mil insulated wire was observed. The magnet was layer wound and produced a field of 1540 gauss/amp. The measurements covered a range of 0-10 amp, hence 0-15,400 gauss. The field was swept at a constant rate at various pre-selected values. Detection was achieved by means of two coils of copper wire wound in series opposition and located on either side of the geometrical center of the solenoid. This arrangement gave a small signal for the rates of field sweep used, but a larger signal for more rapid flux changes, or for flux changes not uniform along the solenoid. It is concluded that the observations on flux annihilation do not contradict any previous models of flux motion, but rather require the additional assumption of a variety of large scale defect structures presenting a wide range of potential barriers. (J.F.P.)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies

1133 (IDO-17075) CEP. A MONTO CARLO PROGRAM FOR THE CALCULATION OF FIRST-FLIGHT ESCAPE PROBABILITIES FOR FINITE CYLINDERS. Foell, W. K.; Berner, C. W.; Tong, S. (Phillips Petroleum Co. Idaho Falls, Idaho. Atomic Energy Div.). Sept. 1965. Contract AT(10-1)-205. 21p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Cylinder Escape Probability (CEP) is a Monte Carlo Program for computing the first-flight escape probability of neutrons from finite cylinders, written in the MAP language for the IBM 7040 computer. Either one cylinder or two concentric cylinders (of which the inner may be empty) of the same height may be used. Each cylinder is subdivided into smaller cylindrical volumes, or cells, for the purpose of a uniform neutron source distribution. There is a provision for reading in a non-uniform source distribution, or weight, as a function of radius and height for each cell. A representative particle from each cell is followed along randomly generated direction cosines until it escapes from the system, producing a probability of escape for the particle in that cell. The sum of the resulting probabilities, weight-averaged over all the cells, yields the total neutron escape probability for the cylinder(s). A Student-t statistical analysis is computed for the probability of escape in each problem. Typical results are given, including a com-

parison with escape probabilities obtained from average chord length considerations. (auth)

1134 (ORNL-P-1604) METHOD FOR OBTAINING BURSTS OF POLARIZED NEUTRONS WITH ENERGIES 10–700 Kev. Dabbs, J. W. T.; Harvey, J. A. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 6p. (CONF-650928-6). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Conference on Polarization Phenomena of Nucleons, Karlsruhe, Ger.

The polarization of fast neutrons by scattering on a one cm layer of liquid helium is discussed. A survey of possible moderators which could be expected not to depolarize the beam was made. Estimated intensities for both graphite and water moderators are given, as obtained from a Monte Carlo calculation. (M.O.W.)

1135 (RT/FI(65)12) AVERAGE COSINE OF THE SCATTERING ANGLE FOR PARTICLES IN A MAXWELLIAN GAS. Marsico, B.; Molinari, V. G.; Scozzafava, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1965. 19p. Dep. mn.

An expression for the average cosine of the scattering angle of particles by a gas whose molecules are in motion with a Maxwellian distribution of velocities is derived. The assumption was made that the scattering is elastic and isotropic in the center of mass system. An application is given to the calculation of diffusion coefficient for thermal neutrons. (auth)

1136 AN ANALOGY BETWEEN THE VARIATIONAL PRINCIPLES OF REACTOR THEORY AND THOSE OF CLASSICAL MECHANICS. Kaplan, S. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 23: 234-7(Nov. 1965). (WAPD-T-1818).

A formal parallelism is shown to exist between two classical variational principles governing the time behavior of mechanical systems and two principles relating to the λ-mode eigenvalue problem of neutron group diffusion theory. By identifying the space variable with the time variable and space derivatives (gradients and divergences) with time derivatives, the "usual" variational principle of diffusion theory is shown to be analogous to Hamilton's principle and the diffusion equations are analogous to the Lagrange equations. Hamilton's canonical equations are then analogous to the diffusion equations in first-order form, and the analog of the principle involving the canonical integral is a principle closely related to one proposed recently by Selengut and Wachspress. (auth)

1137 DIFFUSION LENGTH FOR ARBITRARILY ANISOTROPIC SCATTERING. Inoenue, E.; Usseli, A. I. (International Centre for Theoretical Physics, Trieste). Nucl. Sci. Eng., 23: 251-5(Nov. 1965).

For the case of arbitrarily anisotropic scattering in monoenergetic neutron transport theory with no multiplication, the smallest root k_0 of the determinantal equation (which is equal to the inverse of the diffusion length) is considered to be given by an infinite series in powers of the absorption parameter, $(k_0/\Sigma)^2 = \Sigma_{m=1}^{\infty}\alpha_m(\Sigma_a/\Sigma)^m$, where Σ_a is the macroscopic absorption cross section and Σ is the total macroscopic cross section. It is shown that α_m depends only on the first m Legendre moments of the scattering probability. (auth)

1138 THE CALCULATION OF COLLISION PROBABILITIES IN CLUSTER-TYPE FUEL ELEMENTS. Leslie, D. C. (Atomic Energy Establishment, Winfrith, Dorset, Eng.); Jonsson, A. Nucl. Sci. Eng., 23: 272-90(Nov. 1965).

A method of calculating first-flight collision probabilities in cluster geometry is developed. The method is analytic and approximate and is comparable in speed to codes now available for annular geometry. The proposed scheme is based on a consideration of the properties of the nonescape probability from a nonuniform body in the limits of high and low macroscopic cross sections, together with an interpolation procedure that allows one to determine the probability itself with sufficient accuracy. When calculated for combinations of different rings of fuel pins in a cluster, the resulting set of nonescape probabilities enables one to proceed to a determination of the probability of going from one ring to another. The coolant and the fuel pins are treated separately. Results of the method are compared with exact calculations on two fuel-element types of current interest. In these cases the form factor, defined as the ratio of maximum to mean flux in the cluster, is in error by at most 2%. The hyperfine structure in each ring (i.e., the ratio of the mean flux in the coolant to the mean flux in the fuel) is calculated with comparable accuracy. A one-group calculation on a 37-rod fuel element takes approximately 5 sec on an IBM-7090, so that the method is certainly usable for multigroup applications. (auth)

1139 A METHOD FOR PREDICTION OF THE NEUTRON ATTENUATION IN ANNULAR DUCTS. Nilsson, Jan; Sandlin, Rolf (AB Atomenergi, Studsvik, Nykoeping, Sweden). Nucl. Struct. Eng., 2: 323-6(1965).

A calculational procedure for prediction of the attenuation of thermal and fast neutrons in straight air-filled annular ducts is described. The underlying theory, not presented here, takes into consideration arbitrary angular distributions of the source flux and treats both collided and uncollided contributions to the air gap flux. The procedure works also at short distances from the duct mouth. (auth)

1140 BILINEAR AVERAGING FOR DIFFUSION THEORY PARAMETERS [Thesis]. Pitterle, Thomas Arthur. Madison, Wis., Univ. of Wisconsin, 1965. 126p.

Bilinear averaging of group parameters for use in diffusion-theory calculations is evaluated. This procedure averages energy-dependent cross sections over both neutron flux and adjoint spectra. Both perturbation theory and a variational principle are employed to obtain multigroup diffusion theory with bilinear averaged parameters as an approximation to the continuous energy-dependent P-1 equations. These derivations show that with bilinear averaging eigenvalues accurate to first-order errors in the fluxes used to average the cross sections can be obtained. It is also shown that bilinear averaging represents a consistent approximation to the energy-dependent equations for perturbation theory calculations. Extensive numerical calculations were made to compare flux and bilinear averaging procedures for diffusion theory calculations. A few perturbation theory calculations were also carried out. (TCO)

1141 A NORMAL MODE SOLUTION OF THE NEUTRON SLOWING-DOWN PROBLEM [Thesis]. McInerney, Joseph John. University Park, Pa., Pennsylvania State Univ., 1964. 142p.

The neutron transport equation, describing for a given source the distribution of neutrons in velocity and position, is solved under the assumptions of plane symmetry, velocity independent cross sections, and stationary nuclei. The eigenfunctions of the transport equation are found via a combination of Laplace transformation and normal mode expansion. These eigenfunctions are shown to have orthogonality properties and to be complete in a function space of physical interest. A wide variety of neutron transport problems can be solved by an expansion in this set of functions. The expansion coefficients are found either by utilizing the orthogonality properties or by the solution of a singular integral equation. For most cases, the solutions obtained are complicated in their exact form. Nevertheless, with some simple approximations analytical solutions are obtained in terms of well-known functions. These approximate solutions contain the results of all previous analytical methods, as well as having a wider range of validity. However, the exact solutions can be evaluated numerically. (Dissertation Abstr.)

1142 AN ANALYSIS OF THE ERRORS ASSOCIATED WITH THE DETERMINATION OF SPATIAL HARMONICS. Wolberg, J. R. (TECHNION-Israel Inst. of Tech., Haifa). 5p. (CONF-650602-69). Gmelin, AED-CONF-64-219-136.

From American Nuclear Society, 11th Annual Meeting, Gatlinburg, Tenn.

To determine the accuracy to which the harmonic amplitudes can be measured, it is assumed that the system is one-dimensional to facilitate the analysis. This can be accomplished by applying well-known techniques for minimizing the effect of radial harmonics. Values of the natural error found in this way are compared with spectra previously measured. In all cases the agreement is to within 50%. For prediction of the errors associated with the measurements, this degree of accuracy is usually good enough for the proper planning of experiments; and therefore, the use of the derived equation is justified. (J.F.P.)

1143 NEUTRON EMISSIVE TARGET. Shaw, Jacques (to High Voltage Engineering Corp.). U. S. Patent 3,205,564. Sept. 14, 1965. Filed May 2, 1963.

A neutron emissive target for use with an ion beam having an energy greater than one Mev and a current density greater than 1 mamp/cm^2 consists of a member fabricated of sintered, powdered neutron emissive material, such as Be or Li, and a metal backing plate of either Cu or Ag. The powdered material has a grain size in the range of 5 to 15μ and a compacted density in the range of 75 to 95% of ultimate density. (B.L.M.)

Nuclear Properties and Reactions

Refer also to abstract 996.

1144 (AD–614451) THE INTERACTIONS OF 14.6-Mev NEUTRONS IN IRON, ^{7}Li, AND CARBON. Technical Report, October 1, 1963–September 30, 1964. Western, G. T.; Baird, R. C.; Gibbons, F. L.; Williams, J. R. (General Dynamics/Fort Worth, Tex.). Mar. 1965. Contract AF29(601)-6213. 128p. (FZK–210; WL-TR-64-140). CFSTI $4.00 cy, $1.00 mn.

A time-of-flight spectrometer for the measurement of fast-neutron energies was constructed and used to measure the energy and angular distributions of 14.6-Mev neutrons scattered from Fe and C. The neutron differential cross sections for inelastic scattering from Fe were measured at θ_{CM} = 50, 70, and 115 degrees. The neutron differential cross sections for elastic scattering from C and for inelastic scattering from the first level in C were measured at θ_{CM} = 47 degrees and found to be 49.6 ± 3.6 and 21.8 ± 1.7 mb/ster, respectively. Total cross sections for Fe and C were measured as 2.49 ± 0.05 and 1.30 ± 0.02 barns, respectively. The energy and angular distributions of inelastically produced gamma rays from Fe and ^{7}Li were measured using two different types of gamma spectrometers. The differential scattering cross sections for production of the 0.845- and 1.24-Mev gamma rays and for gamma rays in the energy interval $1 < E_\gamma < 10.5$ Mev from Fe were measured for nine angles of emission. The differential cross section for inelastic scattering from the 0.477-Mev level of ^{7}Li was measured as 7.73 ± 0.54 mb/ster at θ_{CM} = 90 degrees. The calculated energy levels for ^{7}Li and ^{56}Fe, using the collective model, are in good agreement with experimental values. The strong-coupling approximation is shown to be valid in both nuclei. (auth)

1145 (BNL–8168) PROTON-NEUTRON COUPLING IN ODD-ODD Re AND Ir NUCLEI. Scharff-Goldhaver, G.; Takahashi, K.; McKeown, M. (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 13p. (CONF-502–23). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Congress of Nuclear Physics, Paris, July 1964.

While the ground state spins of the odd-odd Re (Z = 75) nuclei follow the asymptotic coupling rules for deformed nuclei given by Gallagher and Moszkowski, those of the odd-odd Ir (Z = 77) nuclei, with the exception of Ir^{194}, do not. They also do not follow the coupling rules for spherical nuclei. A study of the rotational bands of even A Re and Os (Z = 76) nuclei shows that the deformation parameters β are larger and the deviations from the I(I + 1) rule smaller in Re than in Os. (auth)

1146 (COO–1120-38) THE ANALYSIS OF ANGULAR CORRELATIONS OF RADIATIVE TRANSITIONS AND AN INVESTIGATION OF EXCITED STATES OF ^{35}Cl [Thesis]. Watson, Denny D. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [nd.]. Contract AT(11-1)-1120. 100p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The angular correlations and linear polarizations of gamma rays from the radiative capture of protons by ^{34}S are measured and analyzed, in order to determine the nuclear properties of ^{35}Cl. (T.F.H.)

1147 (CRRP–1220) MEASUREMENT OF FAST FISSION RATIOS IN NATURAL URANIUM. Bigham, C. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1965. 88p. (AECL–2285). Dep.; AECL $2.00.

Fast fission ratios (^{238}U fissions/^{235}U fissions) were measured to an accuracy of ±2% or better for natural uranium metal, UO_2, and UC single rods and for a series of natural uranium-D_2O lattices. The measurements were made by the well known fission product γ-ray counting technique with a double fission chamber calibration. The accuracy of this calibration and the corrections made for neutron self-shielding, γ-ray self-shielding, gap effect, and interaction effect are discussed in some detail. The results are compared with earlier measurement and with theoretical calculations. The experimental results cover a sufficiently wide range to show that current theoretical treatments are sufficiently accurate for analyses of most of the natural uranium–D_2O lattices of interest. (auth)

1148 (CRRP–1222) TEMPERATURE DEPENDENT RESONANCE INTEGRALS IN UO_2 AND ThO_2. Halsall, M. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1965. 34p. (AECL–2292). Dep.; AECL, $1.00 cy.

The multigroup, multiregion collision probability program, EPITHET, was used for calculations of $^{238}UO_2$, ^{238}UC, and $^{232}ThO_2$ single rod resonance integrals, and also for $^{238}UO_2$ cluster resonance integrals with various coolants. For single rods, results were obtained for four rod sizes and three temperatures, and were fitted to expressions of the form $R.I.(T) = (A + B\sqrt{S/M})\,[1 + \beta\,(\sqrt{T} - \sqrt{T_0})]$ where T is the absolute temperature, S/M is the surface to mass ratio, A and B are constants, and β is the Doppler coefficient and is itself a function of S/M. The results were broken down into partial resonance integrals for use with the 9 group NDA model. Values of A, B, and power series coefficients for evaluating β are given for $^{238}UO_2$, ^{238}UC, and $^{232}ThO_2$. (auth)

1149 (GAMD–6507) CROSS PLOT—A PROGRAM FOR AUTOMATIC PLOTTING OF DIFFERENTIAL NEUTRON CROSS SECTION DATA. Smith, C. V. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). June 28, 1965. Contract AT(04-3)-167. 18p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A means for automatic plotting of cross-section data on the IBM 7044 computer and the Stromberg-Carlson S-C 4020 High-Speed Microfilm Recorder is available. Raw and/or evaluated cross-section data are transferred from punched cards to magnetic tape for use by the CROSS PLOT program on the IBM 7044 computer. CROSS PLOT prepares a second magnetic tape containing plotting instructions, which is then sent to the S-C 4020 for the actual plotting. Graphs are returned in both hard copy, about 9 inches square, and microfilm. (auth)

1150 (IFA-FT–55) ALPHA REDUCED WIDTHS ON SUPERFLUID MODEL WITH PROJECTED WAVE FUNCTIONS. Sandulescu, A. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest (Romania)). 1965. 8p. Dep. mn.

On the basis of the superfluid model with projected wave functions, explicit expressions of the reduced widths for alpha transitions to the rotational band of intrinsic states are given. (auth)

1151 (IFA-RN–20) GAMMA RADIATION FROM INTERACTION OF NEUTRONS WITH IODINE NUCLEI. Cristu, M. I.; Popa, M. S. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest (Romania)). Mar. 1965. 41p. Dep. mn.

By means of a gamma scintillation spectrometer and gamma-gamma coincidence arrangement single spectrum and coincidence spectra of the gamma rays emitted in $^{127}I(n,\gamma)^{128}I$ reaction were investigated with an external target of pure iodine and with the NaI(Tl) detector crystal used as internal target. Differences between the spectra recorded with the external and internal target were explained. The energies of the gamma rays separated in the single spectrum are given together with their absolute intensities up to about 500 kev. Coincidence measurements revealed the following cascades: 90–154, 134–134, 154–188, 134–285, 154–230, 188–230, 188–297, 240–764, 376–700, and 950–1370 kev. The information from the single and coincidence spectra measurements were used in the building of the scheme of low-lying levels in ^{128}I. The level scheme is discussed in terms of nuclear multiplets due to the coupling of odd nucleons in the odd-odd nucleus ^{128}I. Assignments concerning the spins and parities of the first levels and of the capturing state are made. (auth)

1152 (IFA-RN-21) GAMMA-GAMMA ANGULAR CORRELATION MEASUREMENTS OF THERMAL-NEUTRON CAPTURE GAMMA RAYS IN ^{200}Hg. Cojocaru, V.; Dobrescu, S.; Literat, R.; Patrutescu, M.; Petrascu, M.; Stanciu, M. (Institutul de Fizica Atomica, Academia R.P.R., Bucharest (Romania)). May 1965. 18p. Dep. mn.

The angular correlation measurements of gamma rays following the thermal neutron capture in ^{199}Hg are presented. An angular correlation apparatus with two scintillation NaI(Tl) spectrometers and a sum-coincidence circuit were used. Five unknown energy levels were identified. The spins of the "capturing state" and of a few levels were also determined. Two of the five studied transitions were found to be multipolarity mixtures, that were measured. (auth)

1153 (INR–605/VII/PL) DIFFRACTION SCATTERING OF DEUTERONS ON NON-SPHERICAL NUCLEI. Borysowicz, J. (Institute of Nuclear Research, Warsaw (Poland)). Feb. 1965. 16p. Dep.

The diffraction scattering of deuterons by nuclei is studied. Elastic scattering, and inelastic scattering leading to the excitation of collective states in nuclei, is investigated. Deuteron scattering is treated as a superposition of the diffraction scatterings of both the neutron and the proton of the deuteron, by applying the Achiezer-Sitenko method. The optical model is used to describe the nucleon-nucleus scattering, instead of the "black nucleus" model used in previous investigations. There is no evidence for the existence of the "universal curve" in the present approach. The results of numerical calculations agree with experiment. (auth)

1154 (JINR-P-2323) ISSLEDOVANIE REAKTSII $^3He + ^3He$. (Investigation of the $^3He + ^3He$ Reaction). Wang Nen-min; Novatskii, B. G.; Osetinskii, G. M.; Tzen Naigun; Chepurchenko, I. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 14p. Dep. mn.

The differential cross sections for the $^3He + ^3He$ reaction were measured at 90° in the range 500–1700 kev using a thin gaseous target. The angular distributions were also measured at 882, 1152, 1250, and 1452 kev. The angular distributions were used to calculate the total cross sections in the energy range 500–1450 kev. (auth)

1155 (JINR-P-2347) OPYTY PO SINTEZU SPONTANNO DELYASHCHEGOSYA IZOMERA V REAKTSII $^{241}Am(n,\gamma)^{242}Am$. (Experiments on a Synthesis of Spontaneously Fissionable Isomer in the $^{241}Am(n,\gamma)^{242}Am$ Reaction). Markov, B. N.; Pleve, A. A.; Polikanov, S. M.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1965. 5p. Dep. mn.

Data are presented on the character of production of a spontaneously fissionable isomer ^{242}Am in a reaction involving thermal neutrons. The upper boundary for the cross section and the magnitude of the isomer ratio are given. (auth)

1156 (JINR-P-2370) UPRUGOE RASSEYANIE VYSTRYKH ELEKTRONOV NA YADRAKH S FERMIEVSKIM RASPREDELENIEM PLOTNOSTI ZARYADA. (Elastic Scattering of Fast Electrons on Nuclei With Fermi Distribution of Charge Density). Petkov, I. Zh., Luk'yanov, V. K.; Pol, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 17p. Dep. mn.

An approximate analytical expression for the differential cross section of elastic scattering of fast electrons on medium and heavy nuclei was obtained under the assumption of the Fermi distribution of the charge density. The distortion of the wave function phase for a scattered electron is taken into account in the high energy approximation. The main contribution to the amplitude is given by the poles of the Fermi density. The limiting transition $b \to 0$ (b is the parameter of the density spread) gives an amplitude with a sharp cut-off of the charge density. The results obtained are in good agreement with accurate phase shift calculations. (auth)

1157 (ORNL-P-1616) POLARIZATION STUDIES AT THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Gross, E. E.; Bassel, R. H.; Blumberg, L. N.; van der Woude, A.; Zucker, A. (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 5p. (CONF-650928-7). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Conference on Polarization Phenomena of Nucleons, Karlsruhe, Ger.

Optical model calculations of proton elastic scattering and polarization at 40 Mev by ^{12}C, ^{40}Ca, ^{58}Ni, ^{90}Zr, and ^{208}Pb are carried out. The objective of the calculations is the determination of parameters that can give simultaneous fits to the differential cross sections and polarization data over wide angular ranges (10 to 170° in the laboratory system). (T.F.H.)

1158 (ORNL-TM-1296) COMPARISON OF ^{238}U RESONANCE CALCULATION BY MODIFIED GAM-I, GAM-II AND THE HELLSTRAND FORMULAE. Gift, E. H. (Oak Ridge National Lab., Tenn.). Sept. 30, 1965. Contract W-7405-eng-26. 11p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A comparison was made of the effects of the approximations used in GAM-I-Modified (MGAM) and GAM-II in the computation of resonance shielding of ^{238}U. The numerical results of the NR-NRIA method of MGAM and the integral method of GAM-II were compared with the empirical formulas of Hellstrand. Also compared were the computed effect of Doppler broadening, the Dancoff effects, and the results for a uranium to water volume ratio of 1.0. Differences were observed between the GAM codes and the Hellstrand formulations of up to 7%. Additional differences in the computed cross sections were observed between MGAM and GAM-II which can lead to about 2.0% difference in the computed k_∞. (auth)

1159 (UCRL-16306) VERY LOW ENERGY ISOMER IN THE DECAY OF ^{99}Mo. Cooper, J. A.; Hollander, J. M.; Rasmussen, J. O. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1965. Contract W-7405-eng-48. 19p. (CONF-650563-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Conference on the Internal Conversion Process, Nashville.

An investigation of ^{99}Mo was undertaken in order to resolve some inconsistencies in the decay scheme of this 5.7 hour activity. The multipolarities of the 122- and 258-kev transitions were determined unambiguously by measurements of the L-subshell ratios with the 50-cm iron-free spectrometer. The L-subshell conversion ratios are very sensitive indicators of the multipolarities of transitions, and were usually definitive whenever the L line could be resolved. (M.O.W.)

1160 (WAPD-T-1847) EVALUATION OF CROSS-SECTIONS OF THE FISSIONABLE NUCLIDES. Harris,

D. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1965. Contract AT(11-1)-Gen-14. 15p. (CONF-650524-4). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From European Nuclear Energy Agency and Atomic Energy Commission Seminar, Upton, N. Y.

A discussion on the present situation of nuclear data for fissionable nuclides is presented. The discussion concerns the cross sections for neutrons of energies below 1 ev, fast neutron cross sections, and resolved resonance cross sections. (M.O.W.)

1161 (WASH-1057) COMPILATION OF REQUESTS FOR NUCLEAR CROSS SECTION MEASUREMENTS. Smith, A. B. (comp.) (European-American Nuclear Data Committee). Aug. 1965. Contract W-7405-eng-38. 89p. (EANDC(US)-73(U)). Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Personal requests for particular cross section data are listed. The requests seek data on elastic scattering, non-elastic scattering, fast total and capture, thermal, resonance parameters, and fissile and neighboring nuclei. (M.O.W.)

1162 (AD-619487) AN AVERAGE-VALUE THEOREM IN THE MOESSBAUER EFFECT. Yen, Lu. Translated from Wu Li Hsueh Pao, 18: 483-5(1962. 7p. (FTD-TT-65-599). CFSTI.

In gamma resonance scattering at low temperatures, Mössbauer proved that the atomic nuclei at the lattice points in certain crystals can radiate or absorb γ-photons without recoil. A discussion of the following crystal state is given. The average value of any physical quantity of the crystal after recoil is discussed. An average value theorem was obtained. (M.O.W.)

1163 DETECTION OF THE REACTION $^{28}Si(n,p)^{28}Al$ IN SILICON SEMICONDUCTOR DETECTORS AT NEUTRON ENERGIES OF 14 Mev. Andersson-Lindstroem, G.; Zausig, B. (Institut fuer Experimentalphysik, Hamburg). Ann. Physik (7), 15: 287-93(1965). (In German).

The use of very thick surface-barrier detectors (1 mm deep) in the investigation of neutron-induced nuclear reactions in Si was described. Whereas earlier works in the neutron energy range around 14 Mev were limited to the study of the Si(n,α) reaction, the (n,p) reactions were also observed. A difference method for the separation of the (n,α) and (n,p) spectra was given and the initial results were reported. The pattern of the effective cross section was measured in the region from 13.5 to 14.4 Mev. The results were discussed. (tr-auth)

1164 A SURVEY OF VALUES OF THE 2200 m/s CONSTANTS FOR FOUR FISSILE NUCLIDES. Westcott, C. H.; Ekberg, K.; Hanna, G. C.; Pattenden, N. J.; Sanatani, S.; Attree, P. M. (International Atomic Energy Agency, Vienna). At. Energy Rev., 3: 3-60(1965).

A study of the most probable values of the 2200 m/s constants for the fissile nuclides ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu was undertaken, using a least-squares fitting method. The various experimental data were carefully reviewed, and a set of recommended values for the constants was proposed. A detailed discussion of the problems involved, especially in assessing the accuracy of the individual measurements and of the final output values, is given. (D.C.W.)

1165 NON-ROTATIONAL COLLECTIVE STATES OF DEFORMED EVEN-EVEN NUCLEI. Solovev, V. G. (Joint Inst. for Nuclear Research, Dubna). At. Energy Rev., 3: 117-93(1965).

The non-rotational collective states in deformed even-even nuclei are described. The fundamental propositions of the superfluid nuclear model are stated, and the method of approximate secondary quantization is set forth in detail. The secular equations for the energies of quadrupole and octupole states are derived. The special features of these equations are studied, and the wave functions of the collective states are found. Expressions are also derived for the reduced probabilities of alpha, beta and gamma transitions to collective states. The experimental data on the energies of quadrupole and octupole excited states are systematized, and experimental data are presented on the reduced probabilities of electromagnetic transitions from collective states and on alpha and beta decay to collective states. Energy calculations for the two initial quadrupole and octupole states and for a number of electromagnetic and beta transition probabilities are cited. The structure of collective states and the relation between quasi-particle and collective states are investigated. Theory and experiment are compared and shown to be in good agreement. It is concluded that the superfluid nuclear model correctly describes that part of the residual interactions between nucleons which is of most importance in atomic nuclei at relatively low excitation energies. (D.C.W.)

1166 NUCLEAR TECHNIQUES APPLIED TO SOLID-STATE PROBLEMS. [PART] I. Agullo Lopez, F. (Junta de Energia Nuclear, Spain). Energia Nucl. (Madrid), 9: 43-56(1965). (In Spanish).

The application of nuclear techniques to the study and measurement of nuclear magnetic resonance, angular correlations, and the Mössbauer effect is described. (J.S.R.)

1167 MAGNETIC ANALYSIS OF THE $^{51}V(d,p)^{52}V$ REACTION. Catala, J. (Facultad de Ciencias, Valencia); Garcia, A.; Bolta, J. M.; Marchant, H.; Hinds, S.; Forest, A. E. Nucl. Phys., 74: 1-14(1965).

The energy spectra of protons emitted from a vanadium target bombarded with 10.1-Mev deuterons were measured at 24 angles between 5 and 175° with a high-resolution multi-angle magnetic spectrograph. A total of 37 proton groups were unambiguously ascribed to levels of ^{52}V up to an excitation energy of 3.66 Mev. The angular distributions of all but the weakest groups were analyzed in terms of the distorted-wave Born approximation, and l-values were assigned to 33 states. (auth)

1168 FAST NEUTRON CAPTURE GAMMA-RAY SPECTRUM FROM $^{238}U(n,\gamma)^{239}U$. Bergqvist, I. (Oak Ridge National Lab., Tenn.; Research Inst. of National Defense, Stockholm). Nucl. Phys., 74: 15-26(1965).

The gamma spectrum from the capture of 30-kev neutrons in ^{238}U was measured with a 22.9 cm × 30.5 cm NaI(Tl) spectrometer. Agreement with a statistically calculated spectrum is obtained. Evidence is given for a $K^{\pi} = 1/2^+$ band in ^{239}U at an excitation energy of 0.13 Mev, which can be identified as the [631] $1/2^+$ band. The experimental gamma spectrum is compatible with the number of levels below an excitation energy of about 1 Mev found in other experiments. (auth)

1169 HALF-LIFE AND DECAY PROPERTIES OF ^{78}Ge. Kvale, E.; Pappas, A. C. (Univ. of Oslo). Nucl. Phys., 74: 27-32(1965).

A fast radiochemical procedure for the separation of germanium from a fission mixture was used to obtain strong sources of ^{78}Ge for studies of its decay characteristics. Using scintillation techniques and a Li-drifted Ge-detector, a strong gamma ray of 277 ± 1 kev and a weak one of 294 ± 1 kev were observed. The 277-kev gamma ray is in coincidence with a 710 ± 20-kev beta particle. The half-life of ^{78}Ge is found to be 88.0 ± 1.0 min, measured both directly and indirectly. A tentative decay scheme for ^{78}Ge is proposed. (auth)

1170 EQUILIBRIUM DEFORMATION CALCULATIONS OF THE GROUND STATE ENERGIES OF 1p SHELL NUCLEI. Volkov, A. B. (McMaster Univ., Hamilton, Ontario). Nucl. Phys., 74: 33-58(1965).

The equilibrium ground-state energies of the 1p shell nuclei are calculated by diagonalizing the full many-particle Hamiltonian with saturating forces in an M, rather than J, Slater determinant representation. The single-particle wave functions have variable oscillator constants which preserve cylindrical symmetry. The ground-state energy is minimized with respect to the different oscillator constants. This is equivalent to minimizing the ground-state energy with respect to nuclear volume, nuclear deformation, and, in a limited sense, to the form of the single particle radial functions. In

the zero deformation limit, the diagonalization and minimization with respect to nuclear size is equivalent to finding the best intermediate coupling result for the ground-state energy consistent with the force being used. Most 1p shell nuclei are found to be deformed with the deformation being a sensitive function of the amount of Majorana exchange in the force mixture. For light 1p shell nuclei, the 1p orbitals are considerably larger relative to the 1s orbitals than predicted by the usual simple harmonic single-particle potential. (auth)

1171 ANALYSIS OF ^{3}He-NUCLEUS SCATTERING AND POLARIZATION. Frahn, W. E.; Wiechers, G. (Univ. of Cape Town). Nucl. Phys., 74: 65-72(1965).

Recent measurements by the Birmingham group of the scattering and polarization of 29-Mev ^{3}He particles are analyzed in terms of a simplified version of the strong absorption model. The differential elastic scattering cross section and the polarization for ^{12}C, Sn and Au are fitted by means of three parameters. The values of the parameters for scattering of ^{3}He by different nuclei are found to be consistent. An estimate of the ^{3}He-nucleus spin-orbit interaction indicates that its magnitude is similar to that of the nucleon-nucleus spin-orbit interaction. (auth)

1172 PROTON SPECTRA FROM d + d BREAKUP AT 25.3 Mev. Van Oers, W. T. H.; Brockman, K. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 74: 73-80(1965).

Continuous proton spectra produced by deuteron bombardment of deuterium were studied at an incident deuteron energy of 25.3 Mev. Proton spectra were obtained at 37 different laboratory angles in the range of 7 to 50°. A (dE/dx)−E counter telescope in conjunction with a particle identification system provided the necessary separation between the pulses resulting from the various reaction products. The final results obtained after several background corrections are represented in the center-of-mass system as energy spectra for a chosen set of angles between 15 and 80°. The small angle spectra show a behavior similar to the 0° neutron spectrum measured recently at an energy of 18.6 Mev. The spectra give evidence for the formation of pairs of particles in the final state having non-zero relative angular momenta. For increasing angle the spectra become more and more flat. The angular distribution obtained by integrating the energy spectra shows strong forward peaking. Subsequent integration of the angular distribution results in a proton yield of 340 ± 40 mb. (auth)

1173 MEASUREMENT OF CONVERSION ELECTRONS FROM (p,2n) REACTIONS ON THE VIBRATIONAL NUCLEI. Sakai, Mitsuo; Yamazaki, Toshimitsu; Ejiri, Hiroyasu (Tokyo Univ.). Nucl. Phys., 74: 81-109(1965).

Conversion electrons from (p,2n) reactions with 14-, 13-, and 12-Mev protons on vibrational nuclei were measured by means of a sector-type double-focusing beta spectrometer. The targets used were natural isotopes of the odd-proton nuclei ^{103}Rh, ^{121}Sb, ^{123}Sb, ^{127}I, ^{133}Cs, ^{185}Re, ^{187}Re, ^{191}Ir, ^{193}Ir and ^{197}Au. The conversion lines could be classified into four groups corresponding to the transitions $^12^+ \rightarrow {}^10^+$, $^14^+ \rightarrow {}^12^+$, $^22^+ \rightarrow {}^12^+$ and other weak ones. This classification permits not only the determination of the radiation properties of unknown transitions but also can be used for understanding the mechanism of this type of nuclear reaction. New doublets in ^{120}Te, ^{122}Te, ^{126}Xe, ^{132}Ba, ^{190}Pt, and ^{196}Hg and a number of new levels were discovered. The rotational bands up to the 8$^+$ state and the gamma-vibrational bands in the deformed nuclei ^{184}Os and ^{186}Os were also observed. The reaction mechanism is discussed in terms of the statistical model. (auth)

1174 NOTE ON THE ENERGY OF THE ISOMERIC TRANSITION IN ^{109}Ag. Dingus, R. S.; Talbert, W. L. Jr. (Iowa State Univ., Ames). Nucl. Phys., 74: 110-12(1965). (IS-1180).

It has been observed that the gamma ray emitted during the isomeric transition in ^{109}Ag can excite the K x-ray in Pb, but not in Bi. Thus, the energy of this gamma ray must be between the K-electron binding energies of Pb and Bi, that is between 88.006 ± 0.005 and 90.527 ± 0.005 kev. All but one of the reported values for this energy are less than 88.0 kev. (auth)

1175 MEASUREMENT OF NANOSECOND-LIFETIMES IN DEFORMED NUCLEAR LEVELS. Meiling, W.; Stary, F. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., 74: 112-28(1965). (In German).

Lifetime measurements were performed in the nsec range in the spherical nuclei ^{95}Mo, ^{99}Tc, ^{141}Pr, the spheroidal odd-mass nuclei, ^{153}Eu, ^{161}Dy, ^{175}Lu, ^{181}Ta and the spheroidal even-mass nuclei ^{156}Gd, ^{160}Dy, ^{170}Yb, ^{182}W, using delayed coincidences. Total conversion coefficients for $2^+ \rightarrow 0^+$ rotational transitions calculated from lifetime and Coulomb excitation data agree with the theoretical values within 5% on the average. No striking evidence of a change in the equilibrium shape of the ^{153}Eu nucleus in the 97 kev state could be found. The ground state of ^{156}Eu is ascribed to the configuration $0^+(p_{\frac{5}{2}}{}^+[413], n_{\frac{5}{2}}{}^+[642])$. In ^{175}Lu different values for the lifetime of the 343-kev level resulted from delayed coincidences and resonance fluorescence measurements. A discussion of the influence of high-energy transitions in ^{182}W shows that earlier measurements gave too large values for the lifetime of the 1290-kev level. (auth)

1176 DIFFERENCE SPECTRUM OF ALPHA-PARTICLES AFTER THE BETA-DECAY OF ^{8}Li → ^{8}Be*. Gruhle, W. (Univ., Koeln, Ger.); Lauterjung, K. H.; Schimmer, B.; Schmidt-Rohr, U. Nucl. Phys., 74: 129-38(1965). (In German).

The beta-disintegration of ^{8}Li → ^{8}Be* was studied by recording the energy difference of the two alpha particles simultaneously with the beta particle in four directions at 22, 158 and ±90°. The coefficient for the angular correlation between β-, $\bar{\nu}$- and α-particles was obtained with b = −0.88 ± 0.08. The deviation from the value b = −1 for A coupling may be explained by a small Fermi component. (auth)

1177 THE DECAY OF ^{181}Hf. Funke, L.; Graber, H.; Kaun, K.-H.; Sodan, H.; Werner, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., 74: 139-44(1965).

The decay of ^{181}Hf was studied by means of magnetic beta measurements and two-dimensional $\gamma\gamma$-coincidence investigations. In the beta-spectrum and the $\beta\gamma$-coincidence spectrum no beta-transitions with maximum energies of 550 and 1050 kev were observed. From the conversion electron and single-crystal spectra there is no evidence for the existence of a 699-kev gamma transition. The peaks at 270 and 220 kev, interpreted hitherto as transitions populating or depopulating a level at 699 kev in ^{181}Ta, were found to be caused by simultaneous absorption of 133-(137) kev and 136-kev gamma rays or 133 (136, 137)-kev gamma rays and Kx-rays in the detection crystal. (auth)

1178 ON THE DECAY ^{153}Sm(β^-)^{153}Eu. Funke, L.; Graber, H.; Kaun, K.-H.; Sodan, H.; Werner, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., 74: 145-53(1965). (In German).

From the decay of ^{153}Sm, the level scheme of ^{153}Eu was studied by means of the two-dimensional coincidence technique. Two new gamma-gamma cascades with energies of 150−555 kev and 165−425 kev were found. A proposal for the level scheme of ^{153}Eu with additional excited states at 269.5 ($\frac{1}{2}^+$, $\frac{3}{2}$[411]) and 681.6 kev is given, and a new interpretation of the ^{153}Sm ground state ($\frac{3}{2}^+$[651]) is discussed. It is suggested that the levels at 681.6 and 694.3 kev are beta-vibrational states. (auth)

1179 COINCIDENCE MEASUREMENTS IN THE DECAY OF ^{187}W. Funke, L.; Graber, H.; Kaun, K.-H.; Sodan, H.; Werner, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., 74: 154-60(1965). (In German).

The decay of ^{187}W was investigated by the two-dimensional coincidence technique. The results of gamma-gamma co-

incidence measurements confirm the level scheme of ^{187}Re given by Gallagher. No cascades 777–135, 106–760 and 106–626–135 kev were observed. Therefore, the existence of levels at 760 and 911 kev reported by Michaelis is questionable. From the beta-gamma coincidence measurements, beta transitions with maximum energies of 710, 650, 550 and 470 kev populating levels at 618 (and 625), 686, 773 and 864 (and 880) kev were found. (auth)

1180 ANALYSIS OF THE ^{6}Li(n,^{3}H)^{4}He INTEGRATED AND DIFFERENTIAL CROSS SECTIONS. Mahaux, C. (Univ. of Liege; Max-Planck Institut fuer Kernphysik, Heidelberg); Robaye, G. Nucl. Phys., 74: 161-71(1965). (In German).

The integrated and differential cross sections of the ^{6}Li(n,^{3}H)^{4}He reaction are analyzed in the frame of the S-matrix theory of nuclear reactions for neutron energies less than 600 kev. The experimental data can be satisfactorily accounted for by using a one-level approximation without background in the resonant ($5/2^-$) channel and a constant background approximation in the $1/2^+$ and $3/2^+$ channels corresponding to the s-wave capture of the neutrons. One finds no indication of the presence of a virtual s state in any of the channels corresponding to the s-wave capture; however, the existence of such a virtual state can not be excluded by the present analysis. The contribution of the $1/2^+$ channel to the integrated cross section is approximately three times larger than the contribution of the $3/2^+$ channel. (auth)

1181 PENETRATION EFFECTS IN THE INTERNAL CONVERSION OF ^{203}Tl. Le Tourneux, Jean (Univ. of Virginia, Charlottesville). Nucl. Phys., 74: 172-6(1965).

The ratio of the conversion matrix element to the gamma transition matrix element was calculated, considering only the ground state and the first excited state of ^{203}Tl and treating the nucleus as a proton hole coupled to the core. (D.C.W.)

1182 GAMMA RAY TRANSITIONS IN ^{57}Fe. Sprouse, G. D.; Hanna, S. S. (Stanford Univ., Calif.). Nucl. Phys., 74: 177-83(1965).

The gamma transitions among the low-lying levels of ^{57}Fe were studied with a high-resolution Ge(Li) detector. All possible transitions among the first five states are observed in the decay of ^{57}Co. In the Coulomb excitation of ^{57}Fe by alpha particles, all possible gamma transitions from the 367-kev level are obtained. Energies and intensities of the gamma rays were measured. Log ft values were determined for the decay of ^{57}Co. The observations strengthen previous assignments of $3/2^-$ and $5/2^-$ to the levels at 367 and 707 kev, respectively. (auth)

1183 ^{14}N(p,2p)^{13}C AT 19 Mev ENERGY DISTRIBUTIONS AND ANGULAR CORRELATIONS. Detenbeck, Robert W. (Princeton Univ., N. J.). Nucl. Phys., 74: 184-98(1965).

The proton spectra from nitrogenous targets bombarded with 19-Mev protons show two groups associated with the reactions ^{14}N(p,p')^{14}N, Q = −11.2 ± 0.2 and Q = −12.8 ± 0.4 Mev. The 11.2-Mev group appears prominently in the energy distribution of coincident proton pairs from the ^{14}N(p,2p) reaction leaving ^{13}C in the ground state. For inelastic (Q = −11.2 Mev) proton scattering angles of 45 and 90°, the decay protons leading to ^{13}C (ground state) show strong angular correlations in the reaction plane. The continuum protons between, and presumably beneath the peaks from the 11.2-Mev group show a weaker angular correlation, with some forward peaking. The peaking is more pronounced when one counter is fixed at 45° than it is for 90°. (auth)

1184 FINE STRUCTURE OF THE GIANT DIPOLE RESONANCE IN ^{16}O AS OBSERVED BY INELASTIC ELECTRON SCATTERING AT 180°. Vanpraet, G. J. (Stanford Univ., Calif.). Nucl. Phys., 74: 219-24(1965).

Higher resolution measurements on the giant resonance excitation in ^{16}O were performed by electron inelastic scattering at 180°. Considerably more structure was found than in previous experiments of Goldemberg and Barber. The results indicate that the integrated strength of the giant resonance plotted as a function of momentum transfer q behaves as predicted by the particle-hole calculations of Lewis and Walecka. However, a pronounced shift in dipole strength turned out to be much smaller than predicted by the theory. (auth)

1185 THE (d,p) REACTION OF ^{23}Na IN THE DEUTERON ENERGY RANGE FROM 1.0 TO 2.5 Mev. El-Behay, A. Z.; Farouk, M. A.; Jhingan, M. L.; Nassef, M. H.; Zaloubovsky, I. I. (Atomic Energy Establishment, Cairo). Nucl. Phys., 74: 225-33(1965).

Excitation functions and angular distributions of eight proton groups from the ^{23}Na(d,p)^{24}Na reaction leading to levels of ^{24}Na with excitation energy up to 3.41 Mev were measured. The total and differential cross sections are given. The measured excitation functions show broad maxima at various deuteron energies, which indicate contribution from the compound-nucleus mechanism. Angular distributions show a stripping pattern, predominantly at deuteron energies higher than 2.0 Mev. (auth)

1186 ROLE OF CORE POLARIZATION IN TWO-BODY INTERACTION. Bertsch, George F. (Palmer Physical Lab., Princeton, N. J.). Nucl. Phys., 74: 234-40(1965). (PUC–1965-161).

The correction to the interaction of two valence particles in ^{18}O and ^{42}Sc, due to perturbations of the closed shell wave functions, is calculated and found to be as large as 30% of the first-order interaction. The qualitative behavior of this interaction is: attractive for T = 1, low J states; repulsive for T = 1, high J states; and small for T = 0 states. (auth)

1187 ANALYSIS OF (n,2n) CROSS SECTIONS FOR MEDIUM AND HEAVY MASS NUCLEI. Pearlstein, S. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 23: 238-50(Nov. 1965). (BNL–8828).

The ability to interpret measured (n,2n) cross sections by the statistical model of nuclear reactions was tested. Good agreement was observed for 22 nuclei having mass numbers greater than 30. The statistical model was then applied to nuclei in this mass range to estimate both monoenergetic and fission-spectrum-averaged cross sections. The (n,2n) reaction in structural materials contributes on the order of +0.1% to the reactor multiplication. (auth)

1188 THE GENERALIZED PORTER–THOMAS DISTRIBUTION. Shaker, M. O.; Lukyanov, A. A. (Atomic Energy Establishment, Cairo). Phys. Lett., 19: 197-8 (Oct. 15, 1965).

A method for obtaining the generalized Porter–Thomas distribution for resonance width fluctuations is outlined. (D.C.W.)

1189 MUON CAPTURE BY ^{3}He AND WAVE FUNCTION OF THE TRION. Pascual, R. (Univ., Valencia). Phys. Lett., 19: 221-3(Oct. 15, 1965).

The probability of meson (μ^-) capture by helium-3 was calculated taking into account the fact that the ground-state wave function of the trion is a superposition of terms with different angular momenta. Four different functions were tried for the part of the wave function that depends on the mutual distances between the nucleons. (D.C.W.)

1190 MULTIPOLE SUM RULES FOR SINGLE-NUCLEON-TRANSFER SPECTROSCOPY. Bansal, R. K.; French, J. B. (Univ. of Rochester, N. Y.). Phys. Lett., 19: 223-6(Oct. 15, 1965).

The energy-weighted multipole sum rules for single-nucleon-transfer strengths are derived. The linear sum rule is considered in some detail with emphasis on its applications. (D.C.W.)

1191 SEARCH FOR SPONTANEOUSLY FISSIONING ISOMER OF ^{242}Am FORMED BY THERMAL NEUTRON CAPTURE. White, D. H.; John, W.; Hulet, K. (Univ. of California, Livermore). Phys. Lett., 19: 226-8(Oct. 15, 1965). (UCRL-14386).

An attempt was made to populate the 13-msec fissioning state attributed to ^{242}Am by the reaction ^{241}Am(n,γ)^{242}Am* with thermal neutrons. It was concluded that the results were consistent with the absence of a delayed fission component in ^{242}Am with a half life greater than a millisecond. An upper limit of 10^{-5} was set for the probability of thermal-neutron capture leading to such an isomeric state. (D.C.W.)

1192 A CHANGE FROM STRONG TO WEAK COUPLING BETWEEN ^{25}Mg AND ^{27}Al. Crawley, G. M.; Garvey, G. T. (Princeton Univ., N. J.). Phys. Lett., 19: 228-32(Oct. 15, 1965).

The elastic and inelastic scattering of 17.5-Mev protons from nine 2s-1d shell nuclei was studied. The inelastic scattering from ^{27}Al was observed to differ strongly from that of ^{25}Mg. The results were interpreted in terms of weak-coupling states in ^{27}Al and strong coupling in ^{25}Mg. Measurements on the inelastic scattering from ^{26}Mg and ^{28}Si showed that in the weak-coupling model, the low-lying states in ^{27}Al are preferably regarded as a $d_{\frac{5}{2}}$ hole in the T = 0 nucleus ^{28}Si rather than a $d_{\frac{5}{2}}$ particle added to the T = 1 nucleus ^{26}Mg. (D.C.W.)

1193 ON THE ABSORPTION OF STOPPED π^--MESONS BY ^{12}C NUCLEI. Nguyen-Trung, C.; Cheon, Il-T. Sakamoto, Y. (Kyoto Univ.). Phys. Lett., 19: 232-4(Oct. 15, 1965).

The absorption of a stopped meson (π^-) by a nucleon pair with the emission of a high-energy nucleon was studied. The other nucleon is trapped by the nucleus and renders it highly excited. The excitation energy distribution of the ^{11}B nuclei was calculated. (D.C.W.)

1194 LEVELS IN ^{10}B EXCITED BY THE ^{9}Be(d,n) REACTION. Buccino, S. G.; Smith, A.B. (Argonne National Lab., Ill.). Phys. Lett., 19: 234-7(Oct. 15, 1965).

The energy levels of ^{10}B were studied by measuring angular distributions and spectra for the ^{9}Be(d,n)^{10}B reaction at 2.6, 3.0, 3.1, 3.2, and 7.0 Mev. The angular distributions to the four lowest levels of ^{10}B were compared with DWBA calculations. Spectroscopic factors were obtained for the ^{9}Be(d,n)^{10}B reaction. (D.C.W.)

1195 VELOCITY-DEPENDENT POTENTIAL AND DEUTERON PHOTODISINTEGRATION AT HIGH ENERGIES. Jibuti, R. I.; Mamasakhlisov, V. I.; Macharadze, T. S. (Inst. of Physics, Academy of Sciences, Tbilissi, Georgian SSR). Phys. Lett., 19: 238-9(Oct. 15, 1965).

The influence of the velocity-dependent nucleon-nucleon potential on the cross section of deuteron photodisintegration at high energies is studied. (D.C.W.)

1196 PHOTONEUTRON CROSS SECTION OF ^{12}C. Bazhanov, E. B.; Komar, A. P.; Kulikov, A. V.; Ogurtzov, V. I. (Ioffe's Physical-Technical Inst., Leningrad). Phys. Lett., 19: 239-41(Oct. 15, 1965).

Photoneutron yield curves from ^{12}C were determined from threshold up to 52 Mev using bremsstrahlung. Cross sections were obtained from the yield curves by the Penfold–Leiss method. (D.C.W.)

1197 M1 CHARACTER OF THE 17.64 TO 16.62 Mev TRANSITION IN ^{8}Be. Sweeney, W. E. Jr.; Marion, J. B. (Univ. of Maryland, College Park). Phys. Lett., 19: 243-5(Oct. 15, 1965).

The multipolarity of the 17.64 → 16.62 transition in ^{8}Be was investigated by a gamma-alpha angular correlation measurement. It was concluded that the radiation is almost pure M1. This result supports the proposal that the 16.62-Mev level in ^{8}Be is a single-particle level with the configuration ^{7}Li + p. (D.C.W.)

1198 MOESSBAUER EFFECT OF ^{57}Fe IN A COBALT SINGLE CRYSTAL. Perlow, G. J. (Argonne National Lab., Ill.); Johnson, C. E.; Marshall, W. Phys. Rev., 140: A875-9(Nov. 1, 1965).

The Mössbauer effect of ^{57}Fe in a single crystal of cobalt was observed. The quadrupole coupling e^2Qq was measured to be −0.064 mm/sec, and the hyperfine field was found to be isotropic and equal to −316.6 ± 2.5 G. The significance of these results is discussed in relation to the theory of hyperfine fields in metals. The ratio of the magnetic moments of the excited and ground states of ^{57}Fe was measured to be 1.7135 ± 0.0015. (auth)

1199 ENERGY LEVELS OF ^{143}Pr. Mancuso, R. V. (State Univ. of New York, Buffalo); Roalsvig, J. P.; Arns, R. G. Phys. Rev., 140: B525-30(Nov. 8, 1965).

The gamma rays of ^{143}Pr, following the beta decay of ^{143}Ce, were studied with a scintillation coincidence spectrometer. The existence of levels at 57, 350, 725, 945, and 1167 kev was confirmed. In addition, a level at 493 kev was established. The directional correlation functions for the 668–57-kev, 232–493-kev, and 293–57-kev cascades in ^{143}Pr were measured. A spin of $\frac{5}{2}$ was assigned to the 57- and 725-kev levels and a spin of $\frac{7}{2}$ to the 350-kev level. The spin of the 493-kev level may be either $\frac{5}{2}$ or $\frac{1}{2}$. The experimental level structure is compared with the theoretical predictions. (auth)

1200 DECAY OF $^{129}_{55}$Cs. Shera, E. B.; Burson, S. B. (Argonne National Lab., Ill.). Phys. Rev., 140: B531-6 (Nov. 8, 1965).

The decay of ^{129}Cs [produced by the (α,2n) reaction on ^{127}I] was studied by use of the techniques of scintillation spectroscopy. The half life of this activity was measured as 32.06 ± 0.06 hr. Gamma rays with energies 94, 174, 270, 278, 321, 375, 416, 549, 591, 904, and 945 kev were observed in the singles and coincidence measurements. The 270-kev gamma ray was observed only in the coincidence measurements. Considerable effort was made to derive accurate energy and intensity information from the spectroscopic data. The electron-capture branching ratios to the ground state and excited states were determined from the coincidence measurements; log ft values for the various decay branches were derived from these ratios and the gamma-ray intensity measurements. A decay scheme is presented and compared with the pairing-model calculations of Kisslinger and Sorensen. (auth)

1201 LEVEL STRUCTURE OF ^{131}I. Devare, S. H.; Singru, R. M.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 140: B536-46(Nov. 8, 1965).

The levels of ^{131}I excited in the decay of the 30-hr activity of ^{131m}Te were studied. Scintillation spectrometers were used for recording the gamma spectrum and gamma-gamma coincidences. The internal-conversion spectrum with a double-focusing spectrometer showed K and L lines corresponding to gamma rays of energies 81, 102, and 150 kev and K lines corresponding to 200-, 241-, 336-, 452-, 775-, and 854-kev gamma rays. K conversion lines of 775-, 786-, 797-, 831-, 854-, 869-, 1127-, and 1206-kev gamma rays were observed in the external-conversion spectrum. The relative intensity of the gamma rays was found by analyzing the gamma spectrum and also from the external-conversion spectrum. By use of these relative intensities and the intensities of the internal-conversion lines, the conversion coefficients and the possible multipolarities of the gamma transitions were ascertained. In particular, the 200- and 241-kev transitions were found to be of E1 type, indicating the presence of odd-parity states in ^{131}I. These two transitions were also found to be highly retarded, and the 1829-kev level from which they arise was found to have a half life of 5.9 ± 0.2 mμsec from delayed-coincidence measurements using a time-to-amplitude conversion technique. From these measurements it is concluded that ^{131m}Te decays by beta transitions mainly to the 2012-, 1981-, 1965-, 1931-, and 1902-kev levels of ^{131}I. These levels de-excite by transitions to the levels at 1829, 1629, 1583, 1340, 1145, 1065, 797, 775, 602, and 150 kev. From the beta spectrum studied with an intermediate-image spectrometer, it was concluded that the beta transition to the ground state has an end-point energy of 2460 ± 15 kev and a relative intensity of 6%, while the isomeric transition takes place with a relative intensity of 18%. (auth)

1202 MAGNETIC MOMENT OF THE 99-kev FIRST EXCITED STATE OF ^{195}Pt. Benczer-Koller, N.; Harris, J. R.; Rothberg, G. M. (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 140: B547-9(Nov. 8, 1965).

The Mössbauer effect in ^{195}Pt was measured at 20°K with a ^{195}Au source electroplated onto a platinum foil and $Pt_{0.1}Fe_{0.9}$, $Pt_{0.3}Fe_{0.7}$, $Pt_{0.5}Fe_{0.5}$, and Pt_3Fe absorbers. A split absorption spectrum was observed for the first three absorbers, while Pt_3Fe showed no hyperfine structure. The absorption spectrum of the body-centered cubic $Pt_{0.1}Fe_{0.9}$ is compatible with an internal field at the platinum nucleus in the range $[1.2 \times 10^6 \leq H \leq 2.9 \times 10^6]$Oe and a ratio of the excited- to ground-state magnetic moments $-1.5 \leq \mu_e/\mu_g \leq +0.3$. The measurement by Ho and Phillips of the internal field in a sample of $Pt_{0.03}Fe_{0.97}$, $H = 1.39 \times 10^6$, can be taken as an upper limit for the field value in the $Pt_{0.1}Fe_{0.9}$ sample. The present results can thus be combined with the Ho-Phillips measurement and with the measured ground-state moment to give -0.9 nm $\leq \mu_e \leq -0.7$ nm. The Mössbauer fractions f at 20°K for these absorbers were determined to be (26.9 ± 4.1)%, (23.3 ± 2.6)%, (11.6 ± 0.8)%, and (9.6 ± 1.0)%, respectively. (auth)

1203 PROPERTIES OF THE STATE IN ^{31}P AT 7.14 Mev. Hinrichsen, P. F.; Swann, C. P. (Franklin Inst., Swarthmore, Pa.). Phys. Rev., 140: B549-54(Nov. 8, 1965).

The $^{19}F(p,\alpha\gamma)^{16}O$ reaction was used as the source of Doppler-broadened radiation in the study of resonance fluorescence from a level at 7.144 ± 0.013 Mev in ^{31}P. The angular distribution of the scattered radiation is consistent with a spin of either ½ or ³⁄₂. For a spin of ³⁄₂ the quadrupole-dipole amplitude ratio δ is such that either $+0.15 < \delta < +0.40$ or $-2.5 > \delta > -6.5$. The mean lifetime of the ground-state transition, as determined by a self-absorption measurement, is $\tau_0 = (4.8 \pm 0.6) \times 10^{-16}$ sec for a spin of ½, or $\tau_0 = (1.0 \pm 0.1) \times 10^{-15}$ sec for a spin of ³⁄₂. The resonant scattering cross section is consistent with these values only if little branching to intermediate states is assumed, which is consistent with the observed pulse-height distribution. (auth)

1204 SPIN, HYPERFINE STRUCTURE, AND NEW MAGNETIC MOMENT OF 21-MIN ^{52m}Mn. Phillips, E. A.; Happer, W.; McCullen, J. D. (Princeton Univ., N. J.). Phys. Rev., 140: B555-8(Nov. 8, 1965). (PUC-1965-162).

The hyperfine structure of 21-min ^{52m}Mn was measured by atomic-beam magnetic resonance. The spin is 2, and the magnetic hyperfine constant $|a|$ is 200 ± 4 kc, yielding a magnetic moment $|\mu| = 0.0077(4)$ nm. This unusually small number is in much better agreement with theoretical calculations than the previously reported moment. The value of b is expected to be zero; it was not measured. (auth)

1205 DECAY OF ^{101m}Rh AND ^{101g}Rh. Evans, J. S.; Naumann, R. A. (Princeton Univ., N. J.). Phys. Rev., 140: B559-62(Nov. 8, 1965). (PPAD-2137-553).

The decay of sources containing ^{101m}Rh (4.43 day) and ^{101g}Rh (3.3 yr) was investigated using beta and gamma spectroscopic methods. Conversion-electron data for ^{101m}Rh electron-capture decay were obtained to complement the gamma-ray data appearing in the literature. The observed transition energies 21.58, 127.24, 179.42, 183.9, 233.4, 237.7, 306.67, and 544.9 kev are consistent with a decay scheme including excited levels in ^{101}Ru at 127.2, 306.7, 311.2, (523), and 544.5 kev. The decay of ^{101g}Rh is accompanied by transitions with energies 127.24, 198.4, 295.3, 325.2, and 421.8 kev; and coincidence data require that levels in ^{101}Ru at 127.2, 325.4, and 422.1 kev be populated. The problem of spin assignments for the levels in ^{101}Ru is discussed. (auth)

1206 LOW-INTENSITY FIRST-FORBIDDEN BETA-DECAY BRANCH IN ^{45}Ca. Freedman, M. S.; Porter, F. T.; Wagner, F. Jr. (Argonne National Lab., Ill.). Phys. Rev., 140: B563-5(Nov. 8, 1965).

A weak $[(1.7^{+0.9}_{-0.3}) \times 10^{-5}$ per decay] inner beta branch in the decay of 165-day ^{45}Ca populates the $12.47^{+0.14}_{-0.3}$ kev state in ^{45}Sc, as established by the observation of the K conversion electrons of this transition, superimposed on the 258 ± 2 kev allowed ground-state beta continuum. The $\log f_1 t$ inferred for this probably first-forbidden unique ($\frac{7}{2}- \rightarrow \frac{3}{2}+$) inner group is $9.28^{+0.06}_{-0.10}$. No certain evidence was found for the L lines; the K/L ratio is given as $2 \leq K/L \leq \infty$, with a most likely value of 5. (auth)

1207 THEORY OF MUON CAPTURE WITH INITIAL AND FINAL NUCLEI TREATED AS ELEMENTARY PARTICLES. Kim, C. W.; Primakoff, H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 140: B566-75(Nov. 8, 1965).

The theory of the capture of muons by nuclei ($\mu^- + N_a \rightarrow \nu_\mu + N_b$) is developed, the Nuclei N_a and N_b being treated as "elementary" particles. Form factors are introduced to describe the $N_a \rightarrow N_b$ transition matrix elements of the hadron weak currents; these form factors are then evaluated on the basis of the conserved-vector-current and partially conserved-axial-vector-current hypotheses and with use of appropriate experimental data regarding the corresponding electromagnetic and beta-decay transitions. The reactions $\mu^- + {}^3He \rightarrow \nu_\mu + {}^3H$, $\mu^- + {}^{12}C \rightarrow \nu_\mu + {}^{12}B$, and $\mu^- + {}^6Li \rightarrow \nu_\mu + {}^6He$ are discussed explicitly, and the calculated rates are compared with available measured values. (auth)

1208 PROTON TOTAL REACTION CROSS SECTIONS AT 16.4 Mev. Pollock, Robert E.; Schrank, G. (Princeton Univ., N. J.). Phys. Rev., 140: B575-85(Nov. 8, 1965). (PUC-1965-160).

Total reaction cross sections for protons of a laboratory energy of 16.4 Mev at the center of foil targets of C, Mg, Al, Ni, Cu, and Pb were measured by a beam attenuation method. The technique differs from other measurements with intermediate energy protons in that a double-focusing magnetic spectrometer is contained within the scintillation counter telescope which precedes the target. The magnet selects a beam free from slit-scattered protons, with a precisely determined momentum, while the focusing compensates for the beam divergence in the first detector so that all detectors see comparable counting rates. Solid-state circuitry with controlled recovery characteristics was developed to permit instantaneous rates in excess of 10^6 protons/sec and to circumvent the problem of a low duty cycle. Total reaction cross sections were predicted by optical-model analyses of proton elastic scattering at this energy with a variety of optical potentials. The measured values for Ni and Cu lie somewhat lower than the predictions of the optical model, while the values for Pb and C are higher than the predictions. (auth)

1209 MUON CAPTURE IN ^{3}He. Clay, Douglas R. (Univ. of Utah, Salt Lake City); Keuffel, Jack W.; Wagner, Richard L. Jr.; Edelstein, Richard M. Phys. Rev., 140: B586-600(Nov. 8, 1965). (CAR-882-12).

The rate was measured for capture of negative muons on ^{3}He to form bound ^{3}H. The monoenergetic recoil triton was observed in a ^{3}He gas scintillation target counter, and the rate was normalized to μ-decay electrons observed in surrounding counters. Triton pulses were analyzed in the two dimensions of energy and time with respect to the stopping muon, and with an ultimate energy resolution of 15%, full width at half-maximum, a clean separation could be made between recoil tritons and other muon-associated events. The measured capture rate is 1465 ± 67 sec^{-1}, in good agreement with other experiments and with predictions based on the standard theory of muon capture. Simultaneous limits were calculated for the vector and induced pseudoscalar coupling constants, g_V^μ and g_P^μ, using the results of this experiment and of experiments on muon capture in liquid hydrogen. These are $0.7 < g_V^\mu/g_V^\beta < 1.2$ and $1 < g_P^\mu/g_A^\mu < 17$ with central values of 0.99 and 11.6, respectively. (auth)

1210 PHOTOPRODUCTION OF π^+ IN ^{4}He AND THE POSSIBLE EXISTENCE OF AN UNSTABLE ^{4}H STATE. Argan, P. E. (Univ., Naples; Istituto Nazionale di Fisica Nucleare, Naples); Mantovani, G. C.; Piazzoli, A. Phys. Rev., 140: B601-4(Nov. 8, 1965).

New experimental data on the reaction $\gamma + {}^4He \rightarrow \pi^+ + n + t$ are presented, which extend the preliminary results already published. They confirm the characteristic features of the previous ones, for which the existence of a ^{4}H state

unstable against dissociation could be a likely explanation. (auth)

1211 (d,α) REACTIONS ON ^{12}C, ^{14}N, AND ^{16}O INDUCED BY 24-Mev DEUTERONS. Pehl, Richard H.; Cerny, Joseph; Rivet, Ernest; Harvey, Bernard G. (Univ. of California, Berkeley). Phys. Rev., 140: B605-15(Nov. 8, 1965). (UCRL-11947).

Alpha-particle energy spectra from (d,α) reactions on ^{12}C, ^{14}N, and ^{16}O were obtained using 24-Mev deuterons. The development of a high-resolution semiconductor EdE/dx counter telescope made possible the observation of alpha-particle groups arising from the formation of final states of higher excitation than previously studied by these reactions. Angular distributions corresponding to resolvable final states are presented. Marked variation in the relative cross sections of final states was observed in the energy spectra. In an effort to explain the nature of this preferential population, these final states are correlated, where possible with their expected configurations. A distorted-wave Born-approximation analysis was made for several of the transitions; the outstanding characteristic of this analysis was the strong preference for L = 2 transitions over L = 0 transitions. (auth)

1212 LEVEL ASSIGNMENTS IN ^{17}O FROM $^{13}C(\alpha,\alpha)^{13}C$ AND $^{13}C(\alpha,n)^{16}O$. Barnes, B. K.; Belote, T. A.; Risser, J. R. (Rice Univ., Houston, Tex.). Phys. Rev., 140: B616-22(Nov. 8, 1965). (TID-21915).

$^{13}C(\alpha,\alpha)^{13}C$ cross sections at center-of-mass angles 54.7, 107.9, 142.6, and 169.6° and $^{13}C(\alpha,n)^{16}O$ cross sections at 0° were measured at α-particle energies from 2 to 3.5 Mev. From dispersion-theory analysis, a consistent set of J^{π} and partial-width values was obtained for eleven states of the compound nucleus ^{17}O with excitation energies between 8 and 9 Mev. (auth)

1213 NUCLEAR-STRUCTURE EFFECTS IN HIGH-ENERGY (p,n) REACTIONS. Read, Jacques B. J.; Miller, J. M. (Columbia Univ., New York). Phys. Rev., 140: B623-30(Nov. 8, 1965). (CU-1019-47).

The cross sections for the (p,n) reaction at 370 Mev with ^{44}Ca, ^{48}Ca, ^{51}V, ^{54}Cr, and ^{109}Ag were measured to be 2.0 ± 0.2, 2.3 ± 0.3, 2.2 ± 0.2, 0.72 ± 0.15, and 1.45 ± 0.15 mb, respectively. These results, along with others in the literature, are analyzed in terms of a semiclassical model that considers the direct ejection of the least-bound and the next-least-bound neutrons from the target nucleus by a quasielastic scattering of the incident proton. The spatial distribution of the struck neutrons is taken as that given by the appropriate harmonic-oscillator wave functions. Estimates of the binding energies of neutrons in the first level below that which is least bound result from this analysis. (auth)

1214 MEASUREMENT OF PAIR-PRODUCTION CROSS SECTION NEAR THRESHOLD. Yamazaki, Toshimitsu; Hollander, Jack M. (Univ. of California, Berkeley). Phys. Rev., 140: B630-7(Nov. 8, 1965). (UCRL-16064).

A determination was made of the pair production cross section near threshold in germanium (Z = 32) with use of lithium-drifted germanium gamma-ray detectors. The experimental results show a systematic trend when compared with the theoretical cross sections of Bethe and Heitler. The ratio of the experimental cross section to the Bethe-Heitler theoretical value increases as the photon energy approaches threshold; however, the increase is more rapid than expected from the calculations of Jaeger and Hulme. (auth)

1215 EXCITATION OF QUADRUPOLE AND OCTUPOLE LEVELS OF ^{12}C, ^{16}O, AND ^{40}Ca BY 156-Mev PROTONS. Haybron, R. M. (Oak Ridge National Lab., Tenn.; Michigan State Univ., East Lansing); McManus, H. Phys. Rev., 140: B638-47(Nov. 8, 1965). (ORNL-P-1469).

The inelastic cross sections and polarizations for the excitation of some observed 2^+ and 3^- levels of ^{12}C, ^{16}O, and ^{40}Ca by 156-Mev protons were calculated in the distorted-wave, impulse approximation using the particle-hole transition densities of Gillet and collaborators. The results were compared with available experimental data and good qualitative agreement was obtained; in particular the particle-hole densities provided the necessary enhancements of the cross sections. Fits were also attempted using the theory of collective excitations. These provide reasonable fits to the cross-section data, but not to the polarization. (auth)

1216 $^{62,64}Ni(^3He,d)^{63,65}Cu$ REACTION. Blair, A. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 140: B648-54(Nov. 8, 1965). (LA-DC-7263).

A 22-Mev ^3He-ion beam was used to excite states in ^{63}Cu and ^{65}Cu by means of the $(^3He,d)$ reaction on ^{62}Ni and ^{64}Ni. Levels were analyzed up to approximately 4 Mev of excitation. The angular distributions obtained in the forward-angle region were compared to predictions from a distorted-wave stripping calculation, and orbital angular-momentum transfers and spectroscopic factors were obtained. On the basis of this analysis, large fractions of the $2p_{\frac{1}{2}}$ and $1f_{\frac{5}{2}}$ proton single-particle strengths appear in the first few excited states of ^{63}Cu and ^{65}Cu. This result is in marked disagreement with the predictions of the simple excited-core model, but in fair to good agreement with more extended model calculations. The sums of the spectroscopic factors for each single-particle state are compared with predicted values. Angular distributions were also obtained in the backward-angle region and provide strong evidence for a j-dependent effect for l = 1 transitions. The possible importance of certain secondary-reaction mechanisms is examined briefly. (auth)

1217 PHOTONEUTRON CROSS SECTIONS OF ^6Li. Berman, B. L.; Bramblett, R. L.; Caldwell, J. T.; Harvey, R. R.; Fultz, S. C. (Univ. of California, Livermore). Phys. Rev. Lett., 15: 727-30(Nov. 1, 1965). (UCRL-12376).

The photoneutron cross sections of ^6Li were measured as a function of photon energy from 5.7 to 32 Mev, using a monoenergetic photon beam obtained by the annihilation in flight of fast positrons. On the basis of the observations, it is suggested that there is an appreciable mixing of a bound ^3He–^3H configuration in the ground state of ^6Li. (D.C.W.)

1218 THE CLOSE-PACKED-SPHERON MODEL OF ATOMIC NUCLEI AND ITS RELATION TO THE SHELL MODEL. Pauling, Linus (Center for the Study of Democratic Institutions, Santa Barbara, Calif.). Proc. Nat. Acad. Sci., 54: 989-94(Oct. 1965).

It is shown that many features of nuclear structure can be explained on the basis of the assumption that nuclei consist of closely packed spherons (aggregates of neutrons and protons in localized 1s orbitals — mainly helions and tritions) in concentric layers. Specifically, a simple derivation of a sub-subshell occupancy diagram for nucleons and a simple explanation of magic numbers are obtained. (D.C.W.)

1219 INELASTIC SCATTERING OF FAST NEUTRONS BY NUCLEI WITH A SPECTRUM OF THE COLLECTIVE TYPE. Olkhovskii, V. S. Ukr. Fiz. Zh., 10: 565-6(May 1965). (In Ukrainian).

In analyzing the inelastic scattering of fast neutrons, angular distribution measurements of the 14-Mev neutrons, scattered by ^{24}Mg nuclei were carried out in the center of mass system; the nuclei were excited at a rotational level of 1.37 Mev. The calculations, based on the formulas developed by Yu. V. Tsekhmistrenko, with parametric values close to the usual ones, yielded results which were in good agreement with the experimental data. (TTT)

1220 INVESTIGATION OF THE α-SPECTRUM OF ^{149}Gd. Makhunka, I.; Makhunka, M.; Fenyes, T. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 2: 201-3(Aug. 1965). (In Russian).

The α-spectra of ^{149}Gd and ^{148}Gd produced by spallation of Ta with 660 Mev protons were studied. The measurements were made with a semiconductor α-spectrometer. The obtained results: the ratio of α-particle energies $E(^{149}Gd)/E(^{148}Gd) = 0.9484 \pm 0.0010$, the energy of α-particles the $E(^{149}Gd) = 3.016 \pm 0.010$ Mev, the α-particle half-life $T_{\alpha}(^{149}Gd) = (6 \pm 4) \cdot 10^3$ years. (auth)

1221 THE EXCITED LEVEL 0^+ IN THE ^{4}He NUCLEUS. MIRAGES. Baldin, A. M. (Joint Inst. of Nuclear Research, Dubna, USSR). Yadern. Fiz., 2: 211-14 (Aug. 1965). (In Russian).

The concept of a "mirage"—an excited level with the quantum numbers of the ground state—is introduced on the basis of a simple generalization of the effective radius approximation. The usefulness of this concept is illustrated by analyzing the properties of few-nucleon systems. All characteristics of the excited level 0^+ in the ^{4}He nucleus (including the quantum numbers) can be explained without using model hamiltonians. (auth)

1222 M1 EXCITATION OF THE ^{9}Be NUCLEUS. Grishanova, S. I.; Kabachnik, N. M. (Moscow State Univ.). Yadern. Fiz., 2: 232-5(Aug. 1965). (In Russian).

The form factor of the M1 transition to the 2.4 Mev level of the ^{9}Be nucleus in inelastic electron scattering is calculated on the basis of the nuclear shell model. It is shown that it is necessary to take the existence of two levels, $\frac{1}{2}^-$ and $\frac{5}{2}^-$, into account in this region, so as to obtain agreement with the experimental data. The contribution of the M1-transition form factor to the total form factor is estimated for various scattering angles and initial energies. (auth)

1223 CONVERSION ELECTRONS, EMITTED IN THE REACTION ^{169}Tm(n,γ)^{170}Tm. Balodis, M. K.; Prokofev, P. T.; Simonova, L. I. (Inst. of Physics, Academy of Sciences, Latvian SSR). Yadern. Fiz., 2: 236-8(Aug. 1965). (In Russian).

Low energy transitions between excited levels of the nucleus ^{170}Tm in the reaction ^{169}Tm(n,γ)^{170}Tm are investigated by measuring conversion electrons on a β-spectrograph. A number of previously unknown transitions were obtained. The most probable multipolarity of some transitions are suggested. The position of several low-lying levels in ^{170}Tm is discussed. (auth)

1224 INTERACTION OF 7.2-Gev/c π^- MESONS WITH NUCLEI. Assovskaya, A. S.; Lepekhin, F. G. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 2: 248-9 (Aug. 1965). (In Russian).

56 interactions of π^--mesons with heavy nuclei, accompanied by the emission of two relativistic particles are found by area scanning in 15.2 cm^3 emulsion irradiated by 7.2 Bev/c π-mesons. The cross-section of the charged K-mesons production is estimated to be 9.9 ± 4.7 mb. (auth)

1225 MUON K PRODUCTION IN HEAVY HYPERNUCLEI. Gershtein, S.; Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 2: 257-60(Aug. 1965). (In Russian).

The muonic decay of heavy hypernuclei is investigated. It is shown that the probabilities of processes, in which muons are created in discrete states of μ-mesic atoms, and in the continuous spectrum, are of the same order of magnitude. (auth)

1226 ISOSPIN SELECTION RULES IN PHOTOEFFECTS ON HEAVY NUCLEI. Morinaga, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg; Univ., Heidelberg). Z. Phys., 188: 182-5(1965).

On the basis of the recent discovery of analog state resonances, the isospin selection rules are extended to photonuclear reactions on heavy nuclei. Some characteristics of (γ,p) reactions are explained quite well. (D.C.W.)

1227 COLLECTIVE MOTION IN LIGHT NUCLEI. Brown, G. E. (Nordita, Copenhagen). pp 1.1-19 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

Some recent developments in the description of the energy level structure of light nuclei are outlined. Rotational states in ^{16}O; states in ^{18}O; odd-parity states in ^{15}O, ^{16}O, and ^{17}O; and states in ^{19}F, ^{24}Mg, and ^{20}Ne are considered in some detail. (D.C.W.)

1228 INTRODUCTION TO STRIPPING. Cohen, Bernard L. (Univ. of Pittsburgh). pp 20-68 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

Theory for stripping reactions is reviewed together with the nuclear data that can be obtained from observations on stripping reactions and from comparisons with pick-up reactions. Problems in stripping analyses are outlined together with recent developments in nuclear instrumentation. (D.C.W.)

1229 WHAT CAN WE LEARN ABOUT HEAVY NUCLEI FROM NUCLEAR REACTIONS? Elbek, Bent (Univ. of Copenhagen). pp 69-88 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

The information on the energy level structure of heavy nuclei that can be obtained from studies of nuclear reactions is discussed. The theoretical description of nuclear states is considered as well as some results obtained using a tandem accelerator. (D.C.W.)

1230 SPIN AND PARITY DETERMINATIONS IN s-d SHELL NUCLEI. Endt, P. M. (Rijksuniversiteit, Utrecht, Netherlands). pp 89-97 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

The results of some investigations of the (α,p) reaction on ^{27}Al, ^{19}F, ^{23}Na, and ^{31}P; of levels in ^{31}P from the reactions ^{30}Si(p,γ)^{31}P and ^{30}Si(p,p)^{30}Si; and of levels in ^{27}Al from ^{26}Mg(p,γ)^{27}Al and ^{26}Mg(p,p)^{26}Mg are summarized. (D.C.W.)

1231 SHELL MODEL CALCULATIONS IN THE REGION $29 \leq A \leq 40$. Glaudemans, P. W. M. (Rijksuniversiteit, Utrecht, Netherlands). pp 98-106 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

An analysis of the energy level structure of the nuclei between ^{28}Si and ^{40}Ca is summarized in which an inert ^{28}Si core of closed shells that provides a central field for the outer nucleons was considered. (D.C.W.)

1232 NUCLEAR STRUCTURE INFORMATION FROM TWO-NUCLEON TRANSFER REACTIONS. Hintz, Norton M. (Univ. of Minnesota, Minneapolis). pp 107-37 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

A brief survey on the use of two-nucleon-transfer reactions to obtain information on nuclear structure is presented. The theory of two-nucleon-transfer reactions is summarized, together with some recent experiments on such reactions. An investigation of energy levels in ^{4}He by proton inelastic scattering is also outlined, together with some optical-model analyses of scattering experiments. (D.C.W.)

1233 NUCLEAR PHYSICS WORK WITH THE ELECTRON LINAC. Rae, E. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 138-62 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

A survey on the use of electron linear accelerators in investigations of nuclear structure is presented with specific consideration of neutron time-of-flight studies. Experimental equipment and results are discussed, together with the interpretation of the low-energy cross sections of fissile nuclei. (D.C.W.)

1234 STRUCTURE OF THE THREE-NUCLEON SYSTEM. Schiff, L. I. (Stanford Univ., Calif.). pp 163-9 of Proceedings of the 3rd Nordic-Dutch Accelerator Symposium. Helsinki, Univ. of Helsinki, 1964.

The use of high-energy electron scattering to investigate the structure of the three-nucleon system is briefly discussed. (D.C.W.)

1235 PARAMAGNETIC FIELDS OF NUCLEI. Donner, W.; Suessmann, G. (Universitaet, Frankfurt am Main). pp 1-27 of Ergebnisse der Exakten Naturwissenschaften. 37 Band. Berlin-New York, Springer-Verlag, 1965. (In German).

A theory of the paramagnetic correction of an external magnetic field at the site of the nucleus is developed. (D.C.W.)

1236 GROUP THEORY AND SPECTROSCOPY. Racah, Guiulio (Hebrew Univ., Jerusalem). pp 28-84 of Ergebnisse der Exakten Naturwissenschaften. 37 Band. Berlin-New York, Springer-Verlag, 1965.

Some applications of group theory to the classification of the levels of a nuclear shell and to the calculation in first approximation of the perturbation energy are demonstrated following a development of the general concepts of continuous groups and of the classification and representations of the semi-simple groups. (D.C.W.)

1237 DETERMINATION OF NUCLEAR MOMENTS WITH OPTICAL DOUBLE RESONANCE. zu Putliz, G. (Universitaet, Heidelberg). pp 105-49 of Ergebnisse der Exakten Naturwissenschaften. 37 Band. Berlin-New York, Springer-Verlag, 1965.

A survey on the determination of nuclear moments using optical double resonance is presented. The theoretical bases of the method are outlined, and the results of nuclear moment determinations by this method are reviewed. The application of the method in various groups of the periodic table is discussed in detail. 134 references. (D.C.W.)

1238 INVESTIGATION OF (d,α) REACTIONS ON CERTAIN LIGHT AND MEDIUM WEIGHT NUCLEI AND RELATED ELASTIC SCATTERINGS [Thesis]. Wesolowski, Jerome John. Seattle, Washington Univ., 1963. 137p.

Studies of the direct nuclear reactions (d,p) and (d,n), by measuring the angular distributions of the emitted particles and fitting the distributions using plane-wave and distorted-wave theories, are reviewed. The (d,α) direct reaction was studied with respect to distorted-wave theory. Six (d,α) angular distributions were obtained, using high-resolution solid-state counters. The experimental details of two of them, ^{27}Al(d,α)^{25}Mg and ^{51}V(d,α)^{49}Tl are discussed in detail. Elastic scattering angular distributions were measured for ^{9}Be(d,d), ^{27}Al(d,d), Mg(α,α), and Si(α,α), in order to obtain experimentally the entrance and exit channel parameters for the distorted-wave theory, where possible. The mathematical procedures used to fit the elastic data with optical-model theory and the (d,α) data with distorted-wave theory are discussed. (TCO)

1239 NEUTRON SPECTRA FROM THE PROTON BOMBARDMENT OF LANTHANUM, PRASEODYMIUM AND SEPARATED ISOTOPES OF TIN [Thesis]. Wood, Robert Manning. Madison, Wis., Univ. of Wisconsin, 1965. 118p.

Neutron spectra from (p,n) reactions on La, Pr, and eight separated Sn isotopes at 6-to 14-Mev bombarding energy were measured, using a time-of-flight pulsed-beam spectrometer. Individual neutron groups going to low-lying states in the residual nuclei could be resolved at the lower bombarding energies. At higher energies the neutron spectra varied smoothly with energy. Level densities of the residual nuclei derived from the observed spectra at given excitation energy showed a dependence on bombarding energy, contrary to the predictions of the statistical model. The dependence on bombarding energy could not be removed by varying parameters used in the statistical-model analysis—e.g., assuming a dependence of the inverse cross section on neutron energy and excitation energy. Measured angular distributions gave no evidence of direct reactions. Differences in level density between adjacent odd- and even-mass nuclei can be described using the pairing-energy concept. Pairing energies of ^{117}Sb and ^{119}Sb were derived from the neutron spectra from the tin targets. (TCO)

1240 CIRCULAR POLARIZATION MEASUREMENTS OF GAMMA RAYS FOLLOWING THE BETA DECAY OF ^{124}Sb AND ^{134}Cs [Thesis]. Tirsell, Kenneth Glenn. Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 97p.

Circular polarization measurements of gamma rays following allowed beta transitions in ^{134}Cs and ^{124}Sb were made using forward Compton scattering of the photons from partially polarized electrons in magnetized iron. From the observed coincidence counting rates for opposite orientations of the magnet the value obtained for the ^{134}Cs circular polarization asymmetry parameter was $A = -0.088 \pm 0.019$. Measurements were done relative to ^{60}Co, for which the theoretical value $A = -1/3$ was assumed. From the theoretical relation (computed assuming the V–A beta interaction between A and the Fermi to Gamow–Teller matrix element ratio $Y = C_V M_F / C_A M_{GT}$) the corresponding matrix element ratio for the ^{134}Cs beta transition was determined to be $Y = 0.236 \pm 0.029$. The asymmetry parameter measured for the allowed 0.621-Mev beta transition of ^{124}Sb was $A = +0.407 \pm 0.030$ with the corresponding ratio $Y = -0.226 \pm 0.032$. (Dissertation Abstr.)

1241 HIGH ENERGY PHYSICS PROGRAM: REPORT ON NATIONAL POLICY AND BACKGROUND INFORMATION—JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, 89th CONGRESS, 1st SESSION, FEBRUARY 1965. Washington, D. C., U. S. Government Printing Office, 1965. 180p. $0.55.

The report prepared by the AEC in cooperation with other appropriate Federal agencies is presented on the policy for national action in the field of high energy physics. Also included are other reports and background data, including the major Government-sponsored reviews of the field, beginning with the 1954, 1956, and 1958 Advisory Panel Reports to the National Science Foundation and continuing through the two Piore Panel Reports of 1958 and 1960 and the Ransey Panel Report of 1963. (L.B.S.)

1242 PROTON–GAMMA ANGULAR CORRELATIONS IN THE ^{12}C(d,p)^{13}C REACTION AT LOW ENERGIES [Thesis]. Katman, Thomas Sidney. Durham, N. C., Duke Univ., 1964. 93p.

A study of the ^{12}C(d,p)^{13}C reation leading to the 3.68- and 3.85-Mev states of ^{13}C was made for deuteron energies between 2.0 and 3.0 Mev. Yield curves were obtained at several proton angles, and proton angular distributions were measured for a number of deuteron energies both on and off resonances. Angular correlations between the protons leading to the 3.68-Mev state of ^{13}C and the 3.68-Mev γ rays were measured at deuteron energies of 2.35 and 2.50 Mev, both in the reaction plane and in the azimuthal plane perpendicular to the reaction plane symmetry axis. The angular correlations between the protons leading to the 3.85-Mev state of ^{13}C and the 3.85-Mev γ rays were measured at deuteron energies of 2.35, 2.50, and 2.6 Mev, in the reaction plane and in 2 mutually perpendicular azimuthal planes. The data show that good stripping patterns can exist at low deuteron bombarding energies if the Q value is negative. The very strong 2.50-Mev resonance does not appear to effect the ^{12}C(d,p_3)^{13}C angular correlation. Reduced widths were extracted from the data. (TCO)

1243 THE DECAY OF ^{82}Br [Thesis]. Kenney, Edward Stephen. University Park, Pa., Pennsylvania State Univ., 1964. 96p.

The decay of ^{82}Br was studied with single crystal, sum-coincidence, and fast-slow scintillation spectrometers. The existence of several previously reported low-intensity, high-energy gamma rays is confirmed and associated with newly discovered coincident gamma rays of low energy. A decay scheme is presented which is consistent with the measured data. (Dissertation Abstr.)

1244 AN INVESTIGATION OF (d,p) REACTIONS ON ^{28}Si AND ^{27}Al [Thesis]. Goss, David Lane-Norton. Austin, Tex., Univ. of Texas, 1964. 96p.

Differential cross sections for the ^{28}Si(d,p)^{29}Si reaction leading to the six lowest levels of ^{29}Si were measured at 14 energies between 2.2 and 3.7 Mev in the angular region 5 to 165 degrees. Yield curves for the reactions proceeding to the various levels were measured at 90 and 140 degrees in the energy region 1.7 to 3.7 Mev. Differential cross sections for the ^{27}Al(d,p)^{28}Al reactions leading to the six lowest levels in ^{28}Al were measured at six energies between 1.8 and 2.5 Mev in the angular region 5 to 165 degrees. Yield curves for the reactions leading to these levels were measured at 90 and 160 degrees in the energy region 1.7 to 2.8 Mev. The ground state L = 0 transitions for each of these elements displayed rapid variation of the

angular distributions as a function of bombarding energy. All yield curves showed pronounced uncorrelated fluctuations, indicating that interference processes of some sort contributed appreciably to the reaction cross section. The ground-state experimental angular distributions were compared with those predicted from distorted-wave stripping theory. Qualitative agreement between theory and experiment was obtained, but the optical parameters found appear to be inconsistent with those determined from higher energy data. (Dissertation Abstr.)

1245 OPTICAL SPECTROSCOPY OF RADIOACTIVE MERCURY AND THALLIUM ISOTOPES [Thesis]. Aung, Tin. Berkeley, Calif., Univ. of California, 1964. 142p.

Optical spectroscopic investigations were carried out for Hg and Tl isotopes. Hyperfine structure data are given for ^{197}Hg, ^{195}Hg, ^{193m}Hg, and ^{197}Tl, including spin, magnetic dipole moment, and the ^{193m}Hg electric quadrupole moment. Results of isotope shift measurements are presented for ^{192}Hg, ^{193m}Hg, ^{194}Hg, ^{195}Hg, ^{196}Hg, ^{197}Hg, ^{198}Hg, ^{197}Tl, and ^{205}Tl. (TCO)

1246 ANGULAR MOMENTUM EFFECTS IN THE PHOTOPRODUCTION OF THE ^{52}Mn, ^{44}Sc, AND ^{87}Y NUCLEAR ISOMERS [Thesis]. Walters, William Ben. Urbana, Ill., Univ. of Illinois, 1964. 135p.

Isomeric yield ratios for photonuclear reactions were measured using bremsstrahlung produced by a 300-Mev betatron. The following reactions were studied: ^{45}Sc(γ,n)^{44}Sc, ^{55}Mn(γ,4p7n)^{44}Sc, ^{56}Fe(γ,5p7n)^{44}Sc, ^{55}Mn(γ,3n)^{52}Mn, ^{56}Fe(γ,p3n)^{52}Mn, ^{54}Fe(γ,pn)^{52}Mn, ^{59}Co(γ,2p5n)^{52}Mn, ^{89}Y(γ,2n)^{87}Y, and ^{93}Nb(γ,2p4n)^{87}Y. The measured isomer ratios were interpreted by comparing them with calculated isomer ratios obtained using a compound-nucleus reaction mechanism. Thus values of σ, the spin cutoff parameter, best fitting the experimental data were determined. For the ^{45}Sc(γ,n)^{44}Sc reaction the σ value is in agreement with the σ value predicted for an odd-odd nucleus by a Fermi gas treatment of the nucleus and a rigid-body moment of inertia. For the ^{89}Y(γ,2n)^{87}Y reaction the σ value determined experimentally for ^{87}Y, an odd-even nucleus, is lower than predicted by the Fermi gas treatment and a rigid-body moment of inertia. The lower value can be accounted for by considering pairing interactions between the neutrons. In order to fit the isomeric ratio for the ^{55}Mn(γ,3n)^{52}Mn reaction, a σ value nearly twice the value predicted by the Fermi gas model was required. The difference can be accounted for by considering the angular momentum effects upon the competing reactions. The experimental isomer ratios found for the ^{54}Fe(γ,pn)^{52}Mn reaction can also be accounted for in this manner. The sigma values for the more complex reactions were consistent with the sigma values used for the simple reactions. Calculations were also made for several reactions induced by neutrons and alpha particles which produced ^{44}Sc, ^{52}Mn, and ^{87}Y, where experimental isomer ratios were available. The sigma values which best fit the experimental data were also consistent with those used for the simple photonuclear reactions. (TCO)

1247 THE DISTRIBUTION OF MASS AND CHARGE IN THE FISSION OF ^{238}U INDUCED BY LOW ENERGY PROTONS [Thesis]. Meyer, Eugene Frank Jr. Tallahassee, Florida State Univ., 1964. 106p.

The fission of ^{238}U induced by low-energy protons was studied using radiochemical techniques. Cumulative fission yields were determined for twenty-five nuclides at 12.0, 9.4, and 7.1 Mev. The mass-yield curves showed the presence of two large maxima symmetric about a mass number of 118. The highly asymmetric yields change as rapidly as yields which represent symmetric fission. Fine structure effects were absent. By integrating under the mass-yield curves, total fission cross sections were obtained. A chi-square test applied to the mass-yield data indicated that the two-mode-of-fission hypothesis must be accepted at any level of significance. The independent yields of six shielded or quasi-shielded nuclei were determined to ascertain the mechanism of charge distribution for this system. The data were found to lend support to the postulate of equal charge distribution. (TCO)

1248 SPINS OF ^{153}Gd, ^{159}Dy, AND ^{148}Pm AND HYPERFINE STRUCTURES OF ^{148}Pm AND ^{165}Er [Thesis]. Ali, Dolores E. Berkeley, Calif., Univ. of California, 1964. 107p.

Ground state nuclear spins of ^{153}Gd, ^{159}Dy, and ^{148}Pm were measured by the atomic-beam magnetic-resonance flop-in method. The spins and nucleon state assignments are given. The spin of ^{165}Er was also verified to be $I = 5/2$. The hyperfine-structure interaction constants, a and b, of ^{148}Pm and ^{165}Er were also measured by this method. From the measured interaction constants of ^{148}Pm and ^{165}Er, the nuclear magnetic dipole moments (μ_I) and electric quadrupole moments (Q) were inferred. Only the uncorrected quadrupole moments are given because the Sternheimer shielding has a large uncertainty. The magnetic moment of ^{148}Pm was calculated from the $\langle 1/r^3 \rangle$ value and the measured dipole interaction constant. The Fermi-Segrè formula and the direct measurement of the magnetic moment of ^{167}Er were used to calculate the dipole moment of ^{165}Er. These experiments established the sign of the magnetic moment of ^{148}Pm to be positive. Also, the electronic g_J for the $J = 7/2$ level of promethium was measured, and this value when combined with the data for ^{147}Pm and ^{151}Pm gives a weighted mean of $g_J = -0.8278(1)$. The spins of ^{153}Gd and ^{159}Dy and the moments of ^{165}Er serve as a test of the collective-model predictions for the nuclear properties of deformed nuclei. The ^{148}Pm measurements are consistent with the shell-model predictions for the spin and moments of this odd-odd nuclide. (Dissertation Abstr.)

1249 AN ANALYSIS OF ELECTRON POLARIZATION AND SCATTERING ASYMMETRIES USING THE MULTIPLE SCATTERING THEORY OF TOPTYGIN [Thesis]. Dufner, Andrew Joseph. St. Louis, Univ. of St. Louis, 1964. 114p.

The theory of the Mott double scattering technique as applied to the longitudinal polarization of beta-decay electrons is studied. Mott's theory of the spin-dependent double-scattering process assumes that each of the two events is a single elastic Coulomb scattering. Modifications of this theory to take into account alterations in beam polarization due to multiple scattering in the first scattering foil are analyzed. A spin-dependent single-scattering theory compatible with the Toptygin equations for spin transport intensities was developed; this theory was used in the analysis of the Toptygin transport solutions for their validity in the multiple scattering situations arising in a Mott apparatus. It was found that spin precessions under multiple scattering are negligible for all practical scattering angles, electron energies, and low-Z foils. Thus if multiple scattering can be assured in the first foil, the initial spin expectation components of the beam will be unaltered, to within less than 1%, by such a scattering process. An experimental test of this analysis, using asymmetry results for first-foil scattering, is suggested. (TCO)

1250 EFFICIENT MOESSBAUER SCATTERING TECHNIQUE. Hershkowitz, N.; Eck, J. S.; Walker, J. C. 12p. (CONF-650653-5). Gmelin, AED-CONF-65-170-10.

From American Physical Society, Summer Meeting, New York.

The setup for the technique used is described. To overcome the problem of reduced count rates the scatterer was placed directly on the window of the counter, and at times inside the counter. This allows observation of internal conversion x rays that are scattered into a 2π solid angle. No collimation at all is required but lead shielding is included only to block the x rays from the body of the proportional counter. A nonresonant-energy dependent attenuator is included to block direct radiation from the source, having the energy of the internal conversion x rays. Except for the presence of the attenuator the setup is identical to that used in absorption experiments. If an attenuator can be chosen which completely blocks the noise at the x ray energy but lets through most of the γ rays, simultaneous absorption and scattering experiments may be performed. The nonresonant attenuation of the γ rays and x rays produced in iron-57 are shown. The technique was used to investigate

thin films which could not otherwise be analyzed. It offers the geometric advantage of transmission experiments together with the signal to noise advantages of scattering experiments. (J.F.P.)

1251 MOESSBAUER SCATTERING IN ^{169}Tm. Eck, J. S.; Hershkowitz, N.; Walker, J. C. 7p. (CONF-650653-2). Gmelin, AED-CONF-65-170-11.

From American Physical Society, Summer Meeting, New York.

A more direct estimate is made of the internal conversion coefficient α by observing the scattered internal conversion x rays from thulium-169. Because of the low energy and the high atomic number of ^{169}Tm, the internal conversion takes place with M and N shell electrons. The energy associated with this internal conversion is 1.5 kev. These scattered x rays were observed using forward-scattering geometry. A special counter was built to observe these internal conversion x rays since due to their low energy they will not penetrate even the thinnest window. The data shown were obtained using an aluminum bodied counter. Because of the aluminum L x rays at 1.5 kev there is a large nonresonant background, and thus only a small effect was observed. The Tm x rays at 1.5 kev are very weak and cannot be distinguished from the nonresonant background when a pulse-height spectrum is taken. (J.F.P.)

1252 NUCLEAR SPECTROSCOPY WITH ENERGY RESOLUTION OF A PART PER MILLION. McIntyre, J. A.; Randall, J. D. (Agriculture and Mechanical Univ., College Station, Tex.). 8p. (CONF-650410-10). Gmelin, AED-CONF-65-073-11.

From American Physical Society, Washington, D. C.

A technique for exciting nuclei to energies between 6 and 10 Mev, which also has an energy resolution of a few electron volts, is described. The nuclear excitation is accomplished using electromagnetic radiation, which permits determination of the fundamental electromagnetic transition rates of the levels excited. The excellent energy resolution of neutron-capture gamma rays was utilized in constructing the spectrometer for making these studies. (M.C.G.)

Plasma Physics and Thermonuclear Processes

See also Fluid Physics and Thermodynamics

1253 (AFCRL-65-480) THE THEORY OF CYLINDRICAL ANTENNA IMPEDANCE AS A FUNCTION OF PLASMA FREQUENCY AND TEMPERATURE. Scientific Report No. 1. Despain, Alvin M. (Utah Univ., Salt Lake City. Upper Air Research Lab.). Mar. 3, 1965. Contract AF19(628)-4995. 38p.

A theory of the r-f impedance of a short isolated cylindrical antenna in a plasma is developed. The results indicate a series resonance exists below the plasma frequency where a parallel resonance exists. This series resonance, and indeed the complete impedance function, was found to depend upon the electron temperature, plasma frequency and the antenna physical parameters. Several examples are illustrated. (auth)

1254 (ARL-65-151) NOTES ON PLASMA OSCILLATIONS. Emeleus, K. G.; Jones, J. M. (Queen's Univ., Belfast (Northern Ireland)). July 1965. 31p. CFSTI.

An investigation with the primary aim of finding a correlation between the electron and ion oscillations which occur spontaneously in low-pressure, hot-cathode discharges, in frequency ranges which are typically above about 300 Mc/sec (electron oscillations) and below a few Mc/sec (ion oscillations) is reported. In these discharges, the electron beam, which emerges nearly monoenergetic from the cathode sheath often breaks up abruptly at an oscillation front (meniscus) a few mm from the cathode. It is partly randomised in energy and direction in the process by interaction with the uhf fields of the oscillations which it itself excites and maintains. It was found that if the beams deviated at the front impinge on the wall sheath separating the plasma from the wall of the discharge vessel, they produce further local disturbances from which slow surface waves propagate towards the anode, from whose neighborhood they may be partly reflected, giving rise to a stationary wave on the plasma column. The frequency spectrum of the surface waves is apparently continuous (i.e., they are a form of surface noise) and extends from below 40 Mc/sec to above 1000 Mc/sec. The nature of the waves was established by comparison of their measured propagation characteristics with those computed from the zero temperature quasi-static theory. Under some conditions, which are however not typical of discharges usually employed, growing waves can be produced at the expense of beam energy. (auth)

1255 (ARL-65-171) KERR CELL PHOTOGRAPHY OF A DYNAMICAL DEUTERIUM PLASMA PRODUCED IN A 30 KILOJOULE THETA PINCH. Roberts, H. N.; Gribble, R. F.; Dougal, A. A. (Texas Univ., Austin). Aug. 1965. Contract AF 33(657)-11073. 67p. CFSTI $3.00 cy, $0.75 mn.

A Kerr-cell shutter was employed in a photographic investigation of the space and time history of the luminous ring characteristic of the plasma current sheath in a high-temperature, pure, dense, deuterium plasma formed in the theta pinch geometry. A method is proposed for obtaining rough estimates of relative electron densities from photographically recorded light intensities. The effect that different bias field intensities have on the beginning of the initial inward sweep of the luminosity is correlated with simple theory providing an indication that the current sheath and luminous ring are coincident during the initial inward sweep. Snowplow-model energy calculations are performed. The reverse bias field is concluded to be "trapped" by the current sheath. (auth)

1256 (COO-1233-21) THERMONUCLEAR PLASMA STUDIES. Quarterly Status Report No. 10. (Wisconsin Univ., Madison. Dept. of Physics). July 31, 1965. Contract AT(11-1)-1233. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Further studies with the octupole so that the total picture of the motion of the plasma and the lifetime of hot ions can be seen with one uniform set of operating conditions are reported. The hot ion energy analyzer used previously to observe ions striking the wall perpendicularly, was used with the small iron tube protruding deep into the plasma to extract energetic ions through the shielded channel in the magnetic field. The results of the mean life observations are presented. Brief discussions of plasma research with the linear quadrupole and the inductive gun are presented. Further radio-frequency and theoretical developments are reported. (M.O.W.)

1257 (IAE-769) USKORENIE ELEKTRONOV PLAZMY. (Acceleration of Plasma Electrons). Stefanovskii, A. M. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1964. 37p. Dep. mn.

Acceleration of plasma electrons in a toroidal apparatus was studied when stability of the electron beam in a ring orbit is maintained by image currents excited in a metal housing enveloping a vacuum chamber. The initial plasma was created in a toroidal magnetic field using electron injection along the lines of force and ionization of the neutral gas. Results of the first series of experiments show that most of the plasma electrons are not accelerated in electric fields up to 150 v/em; however, strong plasma oscillations are excited by the nonhomogeneous electric field. These results are analogous to those obtained in plasma betatrons. In the second series of experiments, the accelerating electric field was created uniformly and simultaneously along the initial plasma. Comparison of the plasma density and currents excited in the plasma shows that all the electrons are accelerated initially. Subsequently the acceleration ceases, and the plasma current becomes simply ohmic. The plasma electrons are heated by a short electric-field pulse up to a temperature of 50 to 70 kev,

as indicated by the energy of x rays excited in a 250-v/cm accelerating field. It is assumed that the observed effects can be used to obtain large accelerated fluxes in plasma betatrons. In denser plasmas, electron acceleration to relativistic energies is not successful, however, a strong electric field can be used for heating the electron component of the plasma. (tr-auth)

1258 (LA-DC-7364) LINE SHAPE MEASUREMENTS ON ELECTRON CYCLOTRON HARMONICS EMITTED BY A LABORATORY PLASMA. Dreicer, H. (Los Alamos Scientific Lab., Univ. of California, N. Mex.; Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. Contract W-7405-eng-36. 18p. (CONF-650806-10). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 7th International Conference on Phenomena in Ionized Gases, Belgrade.

Line shape measurements on electron cyclotron harmonics emitted by a helium P.I.G. plasma are reported. The study includes the effect upon the line shape of the inhomogeneity of the magnetic field, the angle of propagation with respect to the magnetic field, and the polarization of the microwave electric field. (auth)

1259 (MATT-366) ON THE INTERACTION OF AN ION BEAM WITH A PLASMA. Enriques, L. (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1965. Contract AT(30-1)-1238. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The marginal stability condition for the excitation of ion waves in a uniform plasma by means of an ion beam of arbitrary density is found as a function of the beam velocity and temperature. Preliminary results of a related experiment performed in the Q-3-T cesium plasma device are also reported. (auth)

1260 (MATT-370) MAXIMAL ORDERING STABILITY PROBLEM. Frieman, E.; Weimer, K.; Rutherford, P. (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1965. Contract AT(30-1)-1238. 26p. (CONF-650935-19. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From 2nd IAEA Conference on Plasma Physics and Controlled Nuclear Fusion Research, Culham, Eng.

In previous investigations, a number of instabilities of hydromagnetic, resistive, and microscopic types were pointed out for plasma containment devices which depend on shear stabilization. An investigation was made to find the relations between these instabilities to determine whether a stable operating regime exists and further whether other modes of instability remain to be discovered. The particular equilibrium considered is meant to be a model for a stellarator although it also may represent other sheared field devices. The philosophy of the calculation consists of ordering the terms that appear in the equations in a single small dimensionless expansion parameter in such a way that the maximum number of physical effects is brought in to compete with one another. (M.O.W.)

1261 (ML-1184) INSTABILITY AND AMPLIFICATION IN FINITE BEAM-PLASMA SYSTEMS. Self, S. A. (Microwave Lab., Stanford Univ., Calif.). June 1964. Contract AT(04-3)-326. 89p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

A study was made, both theoretically and experimentally, of the stability of, and amplification along, a cylindrical electron beam of finite radius passing through a stationary plasma in the absence of steady magnetic field. In the theory, the dispersion relation is analyzed for two cases, when the plasma is unbounded and when it is bounded by a cylindrical conductor. The general criteria for determining instability and wave types were applied and it is found that, when there are no stabilizing effects such as collisions or temperature the system is always absolutely (nonconvectively) unstable. The temporal growth rates of the instability are typically sufficiently low that in practical cases the effect of collisions is sufficient to stabilize the system, leaving it supporting an amplifying wave (convective instability) whose spatial growth rate is determined by the collision rate, and which may be very large indeed under conditions that the absolute instability is only just stabilized. A number of representative numerical solutions are presented which are compared with the experimental results. Experimentally, observations and measurements were made on a beam-generated plasma system in which a beam of perveance $\sim 1 \times 10^{-6}$ amps/volts$^{3/2}$ generates a plasma in mercury vapor of plasma frequency $f_p \sim 10^9$ cps. Dependent on the beam voltage and current and the length of the system, the system may be quiescent or may exhibit beam break-up accompanied by strong high frequency ($\sim f_p$) and low frequency ($0 \sim 200$ kc/s) oscillations. By modulating the beam at frequencies close to f_p, beam breakup could be stimulated in a quiescent system. Measurements of growth rate (up to 15 db/cm) and wavelength along the beam were made with an r-f probe under various conditions. The results are generally compatible with the theory. (auth)

1262 (NASA-CR-309) CURRENT SHEATH DYNAMICS AND MAGNETOSONIC OSCILLATIONS IN MAGNETOPLASMAS. Friedrich, Otto M. Jr.; Dougal, Arwin A. (Texas Univ., Austin). Oct. 1965. 137p. CFSTI $4.00 cy, $1.00 mn.

The electrical breakdown, current sheath formation, and acceleration of current sheaths in deuterium, hydrogen, and argon plasmas are investigated analytically and experimentally. A system of partial differential equations is written from the Maxwell equations and plasma equations to describe the current density, resistivity, electron temperature, ion temperature, and degree of ionization as functions of position and time. The plasma equations include an energy balance equation, an equation relating resistivity to collisions, an ionization equation, and an energy transfer equation. The resulting set of partial differential equations is coded for digital computation on a CDC 1604 computer using finite difference techniques. Theoretical results are obtained for initial deuterium gas pressures of 1, 100, and 1000 μHg. The subsequent motion of dynamic current sheaths in a parallel plate accelerator is calculated using a finite difference technique on an equation of motion based on a snowplow model. (auth)

1263 (NBS-8817) ANALYSIS OF A PULSED REFRIGERATION SYSTEM. Strobridge, T. R.; Muhlenhaupt, R. C.; Mann, D. B. (National Bureau of Standards, Boulder, Colo.). June 1965. 42p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Proposed experiments in controlled fusion research will require supporting low temperature refrigeration systems capable of absorbing variable refrigeration loads at relatively constant temperature. The capacity of these systems demands that careful attention be directed toward insuring efficient and economical operation. Equipment available now can be combined to provide a pulsed refrigeration system capable of meeting a realistic set of requirements. Supporting performance calculations show that the system can provide refrigeration at the required varying rates. Those areas that will require especially careful design are examined. Certain potential operational problems are pointed out and the alternative solutions are discussed. Finally, a recommendation on the configuration of the facility is made and topics requiring further study are given. (auth)

1264 (NBS-8843) ON THE CRYOGENIC ASPECTS OF PROJECT SHERWOOD MAGNETS AND MAGNET MATERIALS. Final Report. Arp, Vincent; Collier, R. S.; Gniewek, J. J.; Jellison, J. C.; Kamper, R. A.; Kropschot, R. H. (National Bureau of Standards, Boulder, Colo.). June 30, 1965. 291p. Dep. mn; CFSTI $6.00 cy, $1.50 mn.

The provision of continuous magnetic fields of high intensity, with a minimum expenditure of power, utilizing the very low electric resistivity of selected metals at low temperatures is investigated. To study cryogenic magnets a liquid hydrogen cooled aluminum electromagnet was designed and built. The detailed design and operation of this magnet are given. Experimental and theoretical investigations were conducted on the properties of materials used for construction. The results for aluminum are presented. To aid the investigation of properties of materials such as Nb_3Sn which require relatively high magnetic fields, a pulsed magnet with relatively long time duration was constructed. The characteristics of this facility are described.

Work on superconductors and how it relates to magnet technology is presented. Several magnets were constructed and their performance was tested. Solutions to the Ginsburg-Landau equations were obtained to compare theory and experiment. Using thin tin films and electron tunneling to study the energy gap, it was demonstrated that the Ginsburg-Landau theory works very well for thin films near the critical temperature and on this basis should be valid for superconductors of more complicated geometry. Results from this investigation are presented. (M.O.W.)

1265 (NBS–8846) ON THE CRYOGENIC ASPECTS OF PROJECT SHERWOOD MAGNET REFRIGERATION. Final Report. Strobridge, T. R.; Mann, D. B.; Muhlenhaupt, R. C.; Chelton, D. B. (National Bureau of Standards, Boulder, Colo.). June 30, 1965. 86p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Accurate prediction of the performance of cryogenic refrigerators is required to realize the full research potential of low temperature magnets. New correlations of the thermodynamic properties of helium, hydrogen, and nitrogen were made to ensure more accurate prediction of cycle performance. Comprehensive analyses of the Joule-Thomson and Brayton refrigeration cycles were completed. Preliminary studies of several other cycles were performed to support other phases of the program. A new system for efficiently providing pulsed refrigeration was conceived to meet the requirements of proposed experiments. (auth)

1266 (NP–15450) A ROTATING PLASMA EXPERIMENT [Thesis]. Insinger, Francois Gerard (Technische Hogeschool, Delft (Netherlands)). 1965. 159p. Dep. mn.

A plasma–physics experiment is described. The work originated from problems encountered in operating an ion–source of an isotope separator under conditions of crossed electric and magnetic field lines. It was then thought that such a field configuration should be tried for plasma heating purposes. A discussion is given of the principle of the method and similar experiments in other countries are evaluated. The motion of a particle in stationary and rotating fields is discussed. The results of the stationary treatment were used to calculate the dimensions of the experiment. Until the present time no experiments which make use of rotating electric and magnetic fields were performed, although theory indicates the possibility for improved plasma confinement. A description is given of the installation and of some of the instruments used for diagnostics. The experimental results are presented. Attempts were made to stress the measurement of local plasma conditions, in contrast to some other work, where deductions were made from external measurements of the effects resulting from changing circuit parameters during or prior to a discharge. A description is given of the conditions, partly dictated by practical considerations, for establishing a satisfactory operating regime of the discharge. Measurements are described which locate the rotating part of the plasma and others which give information concerning the plasma parameters, e.g., density and macroscopic velocity distributions. Experimental results with theoretical calculations are compared for the period in the discharge where conditions are semistationary, i.e., for $t > 75$ μsec. The results yield reasonable temperature distributions and indicate that the plasma is highly ionized. Some additional topics are also discussed, for example, the effect of neutral particles on the conductivity transverse to the magnetic field. (auth)

1267 (NYO–2813-34) BEAM-PLASMA INTERACTION AND RADIATING PLASMA WAVES. Halpern, Gerald; Schmidt, George (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Aug. 1965. Contract AT(30-1)-2813. 50p. (SIT–166). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The interaction between two counter-streaming electron beams and a cold plasma cylinder immersed in a strong magnetic field was considered. It is found that this system, when linearized, has no real frequency eigenmodes. Consequently, the linear theory does not provide for coupling between the growing modes of the beams (two-stream instability) and the radiatively damped modes of the plasma. The dispersion curves for a plasma slab without beams were obtained numerically. Computer results agree with earlier analytic studies, and demonstrate the transitional behavior of these curves in the wide slab limit. Furthermore, it is shown that under certain conditions the slab can execute overdamped plasma oscillations. These may occur when $\omega_p a/c \leq 0.663$, where ω_p is the electron plasma frequency, a is the slab half-width, and c is the speed of light in vacuum. (auth)

1268 (ORNL–3836) THERMONUCLEAR DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING APRIL 30, 1965. (Oak Ridge National Lab., Tenn.). Sept. 1965. Contract W-7405-eng-26. 147p. Dep. mn; CFSTI $5.00 cy, $1.00 mn.

Eleven sections are included; separate abstracts have been prepared for all. (T.F.H.)

For abstracts of individual chapters see: 504, 961, 962, 1120, and 1269–1275.

1269 (ORNL–3836, pp 1-14) INJECTION AND ACCUMULATION—SINGLE-PASS EXPERIMENTS (DCX-1). Dunlap, J. L.; Edwards, R. S.; Haste, G. R. (and others) (Oak Ridge National Lab., Tenn.).

Microinstability-driven losses from the DCX-1 plasma are studied. Observations include the following: the gyrofrequency mode of instability is, on a time-averaged basis, more effective than the diminished-frequency mode in driving radial losses; axial losses driven by the diminished-frequency mode are present, but are of little consequence in comparison with radial losses; and plasmas established by Lorentz dissociation of H_2^+ and of H_2^+ extracted directly from duoplasmatron sources are also subject to instability losses. Unique mode assignments for the observed microinstabilities cannot be made. Theoretically recognized instabilities that cannot be dismissed from consideration in connection with this experiment are the negative mass, drift-cyclotron, maser, and Harris instabilities. Techniques aimed at stabilization by disordering proton orbits are applied. Details of Lorentz trapping of H_2^+ and of H_2^+ beams extracted directly from duoplasmatron sources are given, and some improvements in the injector system are described. (auth)

1270 (ORNL–3836, pp 15-32) INJECTION AND ACCUMULATION—MULTIPLE-PASS EXPERIMENTS (DCX-2). Bell, P. R.; Culver, J. S.; Davis, R. C. (and others) (Oak Ridge National Lab., Tenn.).

The DCX-2 plasma was studied under a wide variety of conditions. Both hydrogen and lithium arcs as well as the background gas and cold plasma were used to dissociate the molecular hydrogen ion beam. The lithium arc was operated on- and off-axis on the side opposite the injector. With the arc off-axis the arc-dissociated protons symmetrically encircled the machine axis with no precession. This arrangement should have emphasized any form of streaming interaction occurring, and in fact the critical current for the appearance of the central peak was below 0.2 ma where previously no central peak had been seen with 0.4 ma injected. The plasma density, however, differed only slightly from that obtained with the lithium arc on-axis and off-axis. The position and tilt angle of the injection duct were varied along with the molecular ion orbit diameter, but these changes in the injection geometry had little effect on the properties of the trapped plasma. An experiment to measure the radial distribution of lithium in DCX-2 indicates an enhanced radial transport of lithium from the main arc column. The lithium arc voltage was varied over a wide range with no significant effect on the density of the trapped plasma, but a broad optimum in arc current was found near the normal operating current of 20 amp. A hydrogen arc has also been run in DCX-2. Fluting of the arc column has prevented a reduction of the pressure in the plasma region. Nitrogen gas dissociation yielded plasma densities less than 1×10^8 ions/cm^3. The ion cyclotron harmonics always prominent in high-energy injection experiments are observed up to the 100th harmonic with relatively high intensity. A new spectrometer permits observation of the r-f above 2 Gc. A probe is de-

veloped with flat response to more than 2 Gc. Structure in the molecular ion beam is discovered. (auth)

1271 (ORNL–3836, pp 33-5) ELECTRON-CYCLOTRON HEATING. (Oak Ridge National Lab., Tenn.).

A 20-kev neutral hydrogen beam is being injected into an electron-cyclotron plasma in the EPA facility. However, because of difficulties resulting from the magnetic-field gradient, the magnetic-field coils are being replaced. The new coils will produce a less-steep radial gradient and a smaller mirror ratio. An electron-cyclotron plasma is successfully formed in the redesigned ELMO facility. The power source used to generate the hot-electron plasma consists of two 8-mm, 1-kw, continuous-wave traveling-wave-tube oscillators. (auth)

1272 (ORNL–3836, pp 36-66) PLASMA PHYSICS. (Oak Ridge National Lab., Tenn.).

Studies using the beam-plasma interaction to "burn out," or highly ionized, a dense cloud of gas contained in a magnetic-mirror machine are continuing. Spectroscopic evidence is given that the helium neutral density in one mirror machine has been reduced by a factor of about 1000 by applying sufficient power to the plasma. Counter experiments suggest that the region between the mirrors is a neutron source with a source strength of 6×10^5 neutrons/sec. Microwave cutoff measurements were attempted in order to determine the plasma density in the large Burnout V mirror machine. Attempts to use a neutral beam of gold vapor to measure plasma density were partly successful. The gold beam was severely attenuated, but was not cut off completely. The neutral-beam transmission sets a value for the plasma density that is too low when compared with other measuring techniques. The mode II reflex discharge has been shown to be an effective means of producing a hot-electron plasma. An experiment has been carried out using the mode II reflex discharge in a geometry in which the arc electrodes are mounted off axis. Properties of collisionless ionic sound waves produced in a quiescent discharge tube have been observed. The density of plasma in a quiescent discharge tube is inferred. A technique is derived for measuring the r-f impedance between grids immersed in a plasma, even though the grids are several wavelengths away from the measuring apparatus. The technique promises to be useful in determining the plasma frequency in the lower plasma density range where microwaves cannot be used. Some of the r-f frequencies observed in the calutron beam are known to shift with pressure. It is shown that this frequency shift is due to electrons, which are oscillating along the magnetic-field line through the positive potential well of the beam (Philips ion gage type of oscillation). Calculations of $\int (\nabla B/B^2)\, dl$ have been carried out for the Gas Arc Facility mirror-coil system and compared with the observed suppression of the flutes in the deuterium arc as a function of anode position. The fields available with the Gas Arc Facility using booster coils are also shown. The hydrogen arc is operated in the long solenoid. Measurements indicate that the core has a high negative potential with respect to ground and carries a large portion of the arc current. Operation of the arc in a mirror field indicates that baffle saturation currents are dependent on magnetic field and position of the baffles. Arc power distribution to the electrodes is included. Multiple inelastic collisions in energetic carbon-arc plasmas appear to provide a mechanism for strong heating of ions by electrons. A downward revision of the usual energy transfer rate for cooling sluggish carbon ions by collisions with cold electrons accentuates the nonthermodynamic nature of such plasmas. (auth)

1273 (ORNL–3836, pp 81-9) PLASMA THEORY AND COMPUTATION. (Oak Ridge National Lab., Tenn.).

Prospects for stable plasma confinement by magnetic mirrors look encouraging. Two stability results particularly concerned with mirror confinement are obtained. It is argued that a magnetic well suppresses all universal modes if $\Delta B/B > T_e/T_i$, where B is the central field, ΔB is the well depth $\perp \vec{B}$, and T_e/T_i is the ratio of electron and ion temperatures. It is shown that flute modes of the mirror-loss cone instability are suppressed if $\omega_{pi}/\omega_{ci} < (R/\rho_i)^{1/2}$, where ω_{pi} and ω_{ci} are the ion-plasma and cyclotron frequencies, ρ_i is the ion gyroradius, and R is the plasma radius. Ion-ion instabilities near the ion gyrofrequency are found in which the perturbed electric field is strictly perpendicular to the external magnetic field if the ion distribution in perpendicular energy is not monotonic. Such distributions occur in mirror containment devices. The instabilities are not damped by providing hot electrons, but achievable spread in the ion perpendicular energy does provide stabilization. A special flutelike case with purely imaginary frequency is hardest to control. A finite one-dimensional plasma consisting of a cold-ion background and a cold-electron stream has been shown to be absolutely unstable when the perturbations are allowed to feed back through a passive, unspecified circuit external to the plasma. These results follow from the solution of the dispersion relation obtained by applying the appropriate boundary condition on the charge-density perturbation of the plasma. This charge-density perturbation is obtained as a solution of a homogeneous, linear, second-order differential equation derived from the zeroth- and first-moment equations describing the ions and electrons. (auth)

1274 (ORNL–3836, pp 111-16) CHEMISTRY OF TRITIUM IN CONTROLLED FUSION DEVICES. Strehlow, R. A.; Richardson, D. M. (Oak Ridge National Lab., Tenn.).

Consideration of fuel-cycle chemistry in tritium-burning controlled-fusion devices must include recognition of possible, intolerably large inventory levels. Steady-state inventory levels in the presence of tritium ion or atom fluxes will be flux dependent but will in any event require appropriate design considerations. Processing for tritium recovery and for isotope separation from protium and deuterium will probably be an essential part of a tritium-burning device. Basic chemical considerations and some experimental corroboration lead to the conclusion that inventory control by processes appropriate to the various regions of a controlled-fusion reactor is chemically possible. (auth)

1275 (ORNL–3836, pp 117-19) FUSION CHAIN REACTIONS. McNally, J. R. Jr. (Oak Ridge National Lab., Tenn.).

The concepts of a negative temperature coefficient and the Grad-Burkhardt effect (for reducing magnetic bremsstrahlung) are discussed briefly in relation to thermonuclear fusion and fusion chain reactions. (auth)

1276 (ORNL-P–1511) DCX-2 BEAM INJECTION DUCT. Brown, R. L.; Bell, P. R.; Culver, J. C. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 19p. (CONF-650512–13). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Livermore, Calif.

The magnetically shielded duct (snout) through which the molecular-ion beam is injected into DCX-2 has a rather severe requirement that it shield the internal channel from an external magnetic field of 12 kilogauss while disturbing the very uniform external field to a negligible degree. Engineering aspects of the latest model snout are presented. (M.O.W.)

1277 (TID–22136) LE CHALUMEAU A PLASMA ET SES APPLICATIONS. (The Plasma Gun and its Applications). Marchandise, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 242p. (EUR–2439.f). Dep. mn; CFSTI $6.00 cy, $1.25 mn.

A review is presented on the main properties of electric arcs and more particularly of the constricted type of arc. Data on plasma properties are also reviewed. A study of the plasma gun itself and the jet of plasma that it produces is presented. Data are given on the influence of several parameters on the electrical characteristics and on the thermal efficiency of a plasma gun. The main parameters examined in detail are: gas flow, nature of the gas, electrode spacing, voltage and current. Results are discussed

and correlated with some general data on the constricted arcs. Among the applications described, spraying of metal powders and ceramic materials was given special development, with references to experimental data from work performed in this field. Some applications in high temperature chemistry are quoted together with other uses of the plasma jet, like metal cutting, welding and furnace-heating. (auth)

1278 (TID–22273) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Quarterly Report No. 1, June 1–August 31, 1965. Lashinsky, H. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-3405. 4p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A report is made on an experimental investigation of universal plasma instabilities under a variety of conditions and a wide range of experimental parameters so that the results can be scaled appropriately to make comparisons with plasmas of thermonuclear interest. In particular, it is proposed to delineate the roles played by collisions and resonance particles (Landau damping and excitation) and to examine the various stages in the development of the instabilities. (M.O.W.)

1279 (UCRL–14233) A SUPERCONDUCTING MINIMUM B MAGNET. Taylor, C. E.; Laverick, C. (Lawrence Radiation Lab., Univ. of California, Livermore). Sept. 3, 1965. Contract W-7405-eng-48. 4p. (CONF-650922–13). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 1st International Symposium on Magnet Technology, Stanford, Calif.

A non-solenoidal, 10-inch-i.d., superconducting magnet for plasma confinement is described. (auth)

1280 (UCRL–16055) INTERCHANGE STABILIZATION BY INCOMPLETE LINE-TYING. Kunkel, Wulf B.; Guillory, John U. (Lawrence Radiation Lab., Univ. of California, Berkeley). Aug. 3, 1965. Contract W-7405-eng-48. 11p. (CONF-650806–14). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 7th International Conference on Phenomena in Ionized Gases, Belgrade.

The phenomenon called "line-tying" in magnetized plasmas requires unimpeded electron flow along the magnetic field and into the bounding surfaces. The nature of the impedance that a low-density plasma and its wall sheath offers to such electron flows is discussed. The result is used to analyze the stabilizing effect of a tenuous background plasma on the growth of flutes in mirror-confined plasmas in the guiding-center approximation. A reduction in growth rate is found, and strong electron emission from the boundaries may be required if the effect is to be pronounced. (auth)

1281 (AD–620824) METHOD OF GENERATING HIGH-VOLTAGE PULSES WITH THE USE OF THE PLASMA PINCH EFFECT. Filippov, N. V.; Vinogradov, V. P.; Golub, G. V. Translated from Russian Patent 168,362, May 8, 1963. 3p. (FTD-TT–65–629). CFSTI $1.00 cy, $0.50 mn.

A method is given for transforming the energy of the rapidly oscillating magnetic field of moving plasma into the energy of an electric field in plasma generators. (M.O.W.)

1282 THE PERTURBATION OF THE THERMAL EQUILIBRIUM OF WEAKLY IONIZED CESIUM CONTACT PLASMAS THROUGH WALL LOSS. von Goeler, S. (Princeton Univ., N. J.). Ann. Physik (7), 15: 321-47 (1965). (In German).

In a cesium plasma produced by contact ionization, the plasma density was measured with Langmuir probes. The measured value of the plasma density lies significantly under the values calculated for the equilibrium by the Saha equations. The cold parts of the emitters (mechanical holders and power supply), which are covered with cesium and take up a large electron current because of their low work function as anodes, were made responsible for this effect. A model that describes this carrier loss mechanism represents the plasma density in a somewhat good agreement with experiment. The electron equilibrium is strongly perturbed on the basis of the convertor effect. Non-Maxwell electron distribution functions occur in the plasma under some conditions. (tr-auth)

1283 DYADIC GREEN'S FUNCTION FOR MAGNETIC CURRENT SOURCE IN COMPRESSIBLE ANISOTROPIC PLASMA. Chen, H. C.; Cheng, D. K. (Syracuse Univ., N. Y.). Electron. Lett., 1: 186-7(Sept. 1965).

By making use of the recently formulated compressivity tensor for anisotropic and compressible media, the dyadic Green's function for a magnetic current source in such media is derived. A dyadic operator is defined, which makes possible the expression of the Green's function in a concise form. (auth)

1284 MODES OF PROPAGATION IN A BOUNDED COMPRESSIBLE PLASMA. Wait, J. R. (National Bureau of Standards, Boulder, Colo.). Electron. Lett., 1: 193-4(Sept. 1965).

The boundary condition which requires the vanishing of the normal component of electron velocity is shown to lead to results which are consistent with cold-plasma theory if the temperature is sufficiently low. This fact is demonstrated by examining the modes in a parallel-plate waveguide filled with compressible plasma. (auth)

1285 ON ELECTROMAGNETIC WAVE SCATTERING IN PLASMA. Gorbunov, L. M.; Pustovalov, V. V.; Silin, V. P. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zavedenii, Radiofiz., 8: 461-8(1965). (In Russian).

The scattering effective area for Langmuir and transverse waves was determined at frequencies near Langmuir's frequency for electrons using nonlinear integral equations describing the electromagnetic wave interaction in plasma. (auth)

1286 ELECTROMAGNETIC WAVE TRANSFORMATION IN NONEQUILIBRIUM PLASMA. Daneliya, I. A.; Tsintsadze, N. L. (Inst. of Physics, Academy of Sciences, Georgian SSR; Tbilissi State Univ., USSR). Izv. Vyssh. Ucheb. Zavedenii, Radiofiz., 8: 469-75(1965). (In Russian).

The processes of electromagnetic and plasma waves transformation on the critical fluctuations of transverse and longitudinal field in plasma were investigated. The transformation coefficients are shown to increase greatly near the instability threshold. The influence of secondary wave field upon the averaged velocity distribution of particles was studied. (auth)

1287 THERMAL RADIATION OF PLASMA CYLINDER. Yakimenko, I. P. (Khar'kov State Univ.). Izv. Vyssh. Ucheb. Zavedenii, Radiofiz., 8: 476-84(1965). (In Russian).

The spectral power distribution of the thermal radiation of a magneto-active plasma cylinder was found. In the case of an isotropic plasma the relations obtained yield the known Rytov's formulae for the thermal radiation of the dielectric cylinder. The case of a thin plasma rod was studied. Here the geometric optics approximation is invalid and the classical theory of thermal radiation is not applied. (auth)

1288 FURTHER ANALYSIS OF PROPAGATION OF PLASMA WAVES IN A SPOKE-WHEEL MAGNETIC FIELD. Gold, Richard R. (Aerospace Corp., El Segundo, Calif.). J. Res. Nat. Bur. Stand., D, 69D: 1227-33(Sept. 1965).

A recent study by R. L. Liboff of electromagnetic wave propagation in plasmas with a specific type of two-dimensional applied magnetic field is continued. The plasma is assumed to be of uniform density in general, and a "spoke-wheel" magnetic field is considered which varies as the inverse radius. Perturbation series are obtained for the first Fourier component of the electric field for several limiting cases. Both the separate cases of a radial and a circular magnetic field are considered, the former in greater detail, and collisions are included. By suitable nondimensionalization, two parameters arise naturally in the present analysis, thus affording a more general solution which should be particularly useful in subsequent applications. (auth)

1289 PULSE SHORTENING IN THE DUOPLASMATRON TYPE ION SOURCE. Tawara, Hiroyuki (Hitachi Ltd., Japan). Jap. J. Appl. Phys., 4: 687-91(Sept. 1965).

An arc-pulsing method is widely used to obtain high-intensity pulsed ion beams from the duoplasmatron-type ion source. In this method, it is found that anode current and, therefore, ion current pulse widths are smaller than the voltage pulse width applied to the cathode. Factors affecting pulse shortening, such as gas pressure in discharge region, applied voltage, etc., were investigated. Pulse shortening in the ion beam current may be caused by the formation of the semispherical-shaped double electric layer, which focuses and accelerates electrons in plasma, near the cathode side of the capillary of the intermediate electrode. (auth)

1290 CONTINUOUS TRANSITION FROM A BACKWARD TO A FORWARD IONIZATION WAVE. Pekarek, L.; Krejci, V.; Stirand, O.; Laska, L. (Inst. of Physics, Prague). Phys. Rev. Lett., 15: 721-2(Nov. 1, 1965).

A transient wave, which represents a continuous transition from a forward wave to a backward wave, was observed in a d-c discharge plasma (54% Ne, 46% H) at a total pressure of 1.25 torr and a current of 30 mamp in a discharge tube with an internal diameter of 1.7 cm. A dispersion curve was calculated for the transient wave. (D.C.W.)

1291 ON THE RADIATIONAL ACCELERATION OF PLASMA. Gurevich, A. V.; Silin, V. P. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 2: 250-6(Aug. 1965). (In Russian).

The mechanism of the acceleration of non-transparent plasma by an electromagnetic wave is considered. The character of the internal motion in the accelerated plasma layer is explained. Problems are discussed concerning the wave energy dissipation and the plasma stability, imitating the possibilities of this acceleration mechanism. (auth)

1292 POLARIZATION MODIFICATIONS OF MICROWAVES IN PENETRATION THROUGH A LOW-PRESSURE PLASMA. Hess, Walther; Raeuchle, Eberhard; Stuetzle, Dietmar (Technische Hochschule, Stuttgart). Z. Angew. Physik., 19: 211-14(1965). (In German).

A polarization modification of linear polarized electromagnetic waves (f = 10 BHz) in penetration through a magnetic field-free plasma was experimentally established. The positive column of a low-pressure discharge in neon, argon, krypton, or xenon at a neutral gas pressure between 0.1 and 2 torr was used as a plasma source. The research showed that from the linear polarized penetrating wave at a given electron density an elliptical polarized wave arises. The effect of the discharge parameters, type of gas, neutral gas pressure, and electron density, on the polarization modification was experimentally studied. It is shown that the occurrence of the effect is dependent only on the contribution of the electron density and occurs at two discrete electron densities which differ from each other by a factor of two. With the help of a model in which it was assumed that in the plasma column at a given electron density a velocity field exists for the electron, an interpretation of the measurement results was attempted. It is shown that a plasma in which the electrons possess an azimuthal velocity component proportional to the radius with respect to the wave propagation is equivalent to a magnetoactive plasma. (tr-auth)

1293 INVESTIGATIONS ON THE STATISTICAL VARIATIONS OF THE INFRARED RADIATION OF A HIGH-PRESSURE, HIGH-CURRENT ARGON DISCHARGE. PART I. SPONTANEOUS RADIATION VARIATIONS OF A NON-BLACK RADIATOR AND THEIR MEASUREMENT WITH AN In–Sb PHOTODIODE. Gubler, W.; Strutt, M. J. O. (Technische Hochschule, Zurich). Z. Naturforsch., 20a: 1011-18(Aug. 1965). (In German).

By the Bose-Einstein statistics, the equations describing the spontaneous fluctuations of photon radiation are given. These equations are applied to the thermal photon radiation of a nonhomogeneous plasma. The fluctuations may be described by a degeneration factor μ which is calculated in general terms and especially for an argon plasma. By using a highly sensitive photodetector which transforms radiation fluctuations into current fluctuations at its output, the degeneration factor μ can be determined. The properties of a cooled InSb-photodiode are then investigated. It is shown that this detector is useful for measuring photon noise at about 5 μ wavelength of an argon plasma. The actual measurements are included. (auth)

1294 ONE-DIMENSIONAL PLASMA FLOW IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Rebhan, E. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 20a: 1019-26(Aug. 1965). (In German).

An investigation was made of a steady, one-dimensional plasma flow in crossed electric and magnetic fields. The interaction between the flow and the fields causes various flow types. In general, the flow is either supersonic or subsonic in the entire channel. Under certain circumstances, however, a transsonic flow may develop. Finally, flows exist with a steady shock front, the position and strength of which depend on the magnetic field strength and the pressure at the end of the tube. (auth)

1295 CALCULATIONS ON THE ISENTROPIC EXPANSION OF AN ARGON PLASMA IN A LAVAL NOZZLE. Artmann, J. (DVL-Institut fuer Plasmadynamik, Stuttgart). Z. Naturforsch., 20a: 1027-45(Aug. 1965). (In German).

Neglecting magnetic and electric forces that occur in the expansion of a plasma in a Laval nozzle the plasma parameters were calculated by means of a simplified model under the condition of isentropic flow. A one-step model and a two-step model are applied. It proves that the experimental results at hand can only be explained by means of the two-step model. The calculations include the case of thermodynamic equilibrium as well as that of frozen flow. (auth)

1296 PLASMA DIAGNOSTICS BY SECOND DERIVATIVE METHODS. Friar, E. M. Jr. (Electronic Research Branch, Wright-Patterson AFB, Ohio). pp 696-9 of Proceedings of the National Electronics Conference. Vol. XIX. Chicago, National Electronics Conference, Inc., 1963.

The use of the second derivative of the Langmuir Probe characteristic to obtain the electron energy distribution in a low temperature plasma is discussed. In particular the two methods currently in use in the Electronic Technology Division will be described. Both systems use Druyvesteyn's analysis; one system measures the second harmonic generated when a small ac signal is impressed on the probe, while the other uses the intermodulation of two sinusoidal signals. The significance of the resulting energy spectrum, which is often quite non-Maxwellian, is discussed. (auth)

1297 INVISCID NON-EQUILIBRIUM FLOW OF AN EXPANDED AIR PLASMA [Thesis]. Petrie, Stuart Lee. Columbus, Ohio, Ohio State Univ., 1964. 153p.

The chemical and thermodynamic processes which occur in the effluent generated by an arc-heated wind tunnel were examined theoretically and experimentally. The complete set of equations which describes the flow of an accelerating chemically reacting and thermodynamically relaxing diatomic gas is presented. The chemical and thermodynamic relaxation rates were examined, and an approximate method of solution of the governing equations is proposed. It is shown that both the static temperature and static pressure of the flow are sensitive to the amount of chemical recombination. The impact pressure is relatively insensitive to the degree of chemical recombination. Experimental studies of the flow in an arc-heated wind tunnel operating with an air effluent are reported. The impact pressure, rotational temperature, and vibrational temperature were measured at various points in a direction transverse to the flow downstream of the nozzle exit. Static pressures along the nozzle wall also were measured. An electron

beam generator employed for the temperature measurements produces a narrow beam with energies near 20,000 volts, providing good spatial resolution. The radiation caused by the electron beam is due principally to the first negative emission system of the ionized nitrogen molecule (N_2^+) and the second positive system of nitrogen (N_2). The theoretical analysis for interpretation of this radiation in terms of the rotational and vibrational temperatures of the nitrogen is presented in detail. A complete description of the electron beam generator and the design criteria are presented. Comparisons of the experimental results with those from the approximate theoretical calculations substantiate the existence of an effective flow freezing point for the chemical reactions. Excellent agreement was obtained between the measured rotational temperature and that predicted. The measured vibrational temperatures of nitrogen were found to be significantly lower than predicted by the application of vibrational excitation times obtained from shock tubes in a Landau-Teller relaxation calculation. (TCO)

1298 WAVE PROPAGATION IN A FULLY IONIZED PLASMA WITH UNIFORM VELOCITY [Thesis]. Seversike, Leverne Kenneth. Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 58p.

An analytical investigation is made of the wave propagation in a fully ionized plasma having a uniform velocity in the direction of the wave propagation. The wave modes are studied to determine their phase velocity and damping characteristics as functions of the frequency with and without an external magnetic field. The magnetic field is aligned with the plasma flow velocity. A two-fluid theory description of the plasma is used in obtaining the dispersion equations for the wave modes. Eighteen linearized, homogeneous, algebraic equations are obtained involving eighteen dependent variables. The problem is then an eigenvalue problem in terms of the complex wave number λ and the applied frequency. In general, the wave modes can be separated into two groups, longitudinal waves and transverse waves. The longitudinal waves are found to be independent of the magnetic field. Two longitudinal waves are found to be present, one associated with the ion motion and one with the electron motion. The transverse waves do depend on the presence of a magnetic field. With no external magnetic field present two wave modes are found to be present. With a longitudinal external magnetic field present, three transverse waves appear—a drifting wave and a left-circularly and a right-circularly polarized wave. (TCO)

1299 THEORY AND EXPERIMENT OF A COAXIAL PLASMA ACCELERATOR [Thesis]. Grossmann, William Jr. Blacksburg, Va., Virginia Polytechnic Inst., 1964. 154p.

The overall performance and characteristics of a coaxial plasma accelerator were analyzed. The accelerator consists of a coaxial arc chamber and a conical nozzle region. The application of an externally applied axial magnetic field gives a crossed electric and magnetic field geometry, and the resulting magnetohydrodynamic force on the argon working gas in the electrode chamber is in the azimuthal direction. Steady state d-c operation of the accelerator showed that a completely diffuse electric arc discharge having axial symmetry exists in the electrode region. Spectroscopic and Langmuir probe measurements were made of the electron and the ion temperatures. Calorimetric measurements in the arc chamber showed that the coaxial electrode arrangement combined with the axial magnetic field resulted in arc efficiencies as high as 80 percent. The arc efficiency was found to increase with increasing magnetic field strength for given arc current and mass flow rate. A combination of methods using measured nozzle wall static pressure readings and photographs of the conical shock wave surrounding a conical pressure probe showed that the plasma stream at the nozzle exit was supersonic. The thrust and specific impulse produced by the accelerator were obtained by using a pendulum balance. The thrust measurement allowed a calculation to be made of the overall efficiency of the accelerator. It was found that for the given accelerator configuration, arc current, and propellant mass flow rate an increase in magnetic field strength increases the thrust, specific impulse, Mach number, and over-all efficiency. A theoretical description of the plasma in the diffuse discharge was attempted to predict both the over-all arc characteristics and the plasma properties. A homogeneous slab plasma model was assumed to which were applied steady state continuum conservation equations resulting from appropriate Boltzmann equations. The analysis accurately predicted the voltage versus current with varying magnetic field characteristics and also the Hall current. The theoretical prediction of electron temperature was approximately one-half of the measured values. The difference between the theory and experiment is shown to be related to ionization relaxation times. (TCO)

1300 HIGH FREQUENCY CONDUCTIVITY OF A PLASMA [Thesis]. Thourson, Thomas Lawrence. Evanston, Ill., Northwestern Univ., 1964. 158p.

The classical kinetic equations used to determine plasma properties are invalid at high frequencies. In the classical Fokker-Planck equation and in the Boltzmann equation, it is assumed that the time variation in a gas is very much slower than the duration of a collision. Since a plasma can sustain oscillations at frequencies greater than the plasma frequency, this condition is violated and the classical kinetic equations can not be used. The starting point for the method presented is the classical Liouville equation for a fully ionized plasma in the presence of an applied time and space dependent field. Integration of the Liouville equation leads to the BBKGY equations. The BBKGY equations are approximated by replacing those terms for the correlation function which lead to a screened Coulomb potential by a Coulomb potential with the range of the Debye length, leading to an explicit expression for the correlation function in terms of the single particle distribution function. The correlation function along with the first BBKGY equation constitutes a generalized Fokker–Planck equation, solved by assuming equilibrium at the initial time. A small amplitude applied field in the form of a monochromatic plane wave disturbs the plasma from its equilibrium value. The Fokker–Planck equation is linearized about equilibrium and solved for its asymptotic solution by assuming the high frequency field dominates the effect of the collisions when the frequency, ω_0, is greater than ν, the reciprocal of the 90° deflection time. The results are computed for $\omega_0 > \nu$ and in the long wavelength limit. The results include the dominant effect of the field, the corrections due to electron-ion and electron-electron collisions, and the first finite wavelength corrections. (TCO)

1301 LOW-FREQUENCY STABILITY OF SPATIALLY NON-UNIFORM PLASMAS [Thesis]. Kennel, Charles Frederick. Princeton, N. J., Princeton Univ., 1964. 188p.

Low-frequency plasma wave motions and linear stability are discussed, concentrating upon the effects of spatial inhomogeneity and using the Vlasov–Maxwell equations. A review of developments in plasma stability theory is given, with emphasis upon the inhomogeneous effects exhibited by the universal instability and finite larmor radius (F-L-R) phenomena. The problem of consistency is undertaken. A complete set of low frequency long wavelength macroscopic equations is obtained by an asymptotic expansion with a scaling reflecting the physics in the F-L-R or drift approximation. In effect, time variations are taken an order of magnitude slower than in hydromagnetics. The consequences of the new scaling are outlined for the physical variables in the Vlasov-Maxwell set. A nonlinear set of asymptotic equations is derived rigorously. The drift equations are used to study the stability of a one-dimensional inhomogeneous plasma in a strong external magnetic field and relate the results to hydromagnetics. The equations adequately treat F-L-R stabilization of the interchange mode and give partial information about the universal instability. The stability criterion found may be unreliable, because the spatial eigenfunction is lost altogether. The oscillatory part is adequately described. A careful discussion of the transition to perpendicular propagation, where drift effects are the most striking is given. Asymp-

totic expansions are valid for equilibrium quantities, but often not for linear eigenmodes. An integro-differential equation for the ion-acoustic mode is derived which reduces to the singular eigenmodes or to a second order differential equation with suitable further assumptions upon wavelength. W-K-B solutions of both differential and integro-differential equations are developed to find a stability criterion. Since regions localized within a few ion Larmor radii can be unstable to the universal instability or the resistive interchange, stability requirements for inhomogeneous plasmas are rather stringent. (TCO)

1302 ELECTRICAL TRANSPORT EQUATION FOR A PLASMA MODEL [Thesis]. Berk, Herbert Lester. Princeton, N. J., Princeton Univ., 1964. 197p.

An iteration procedure is developed to derive the transport equation for the plasma model formulated by Dawson and Oberman, extending their analysis to frequencies embracing the collisional frequency and to finite wavelengths. To the logarithmically dominant order, the transport equation is a Fokker–Planck like equation, but the argument of the logarithm depends on the externally imposed frequency. To dominant order, a uniform representation of the frequency dependent conductivity for a Lorentz gas is presented, and finite wavelength corrections are calculated. For frequencies much larger than the collision frequency, the more exact conductivity expression is found. The model offers a description of light scattering from the driven density fluctuations that arise from that part of the collisional contribution that gives rise to plasma wave emission. The iteration procedure is generalized to include a uniform magnetic field. The dominant transport equation is again a Fokker–Planck like equation and its logarithmic structure depends on the magnetic field as well. The quantum generalization of the model is investigated, and the resulting conductivity expression is found to agree with the results of more rigorous calculations. (TCO)

Shielding

Refer also to abstracts 629 and 935.

1303 (AD–614250) FORMULATION OF RADIATION TRANSPORT SOLUTIONS FOR SHIELDING APPLICATIONS, INCLUDING INTEGRAL TRANSFORM METHODS, MATRIX TECHNIQUES, AND ASYMPTOTIC APPROXIMATIONS. Technical Report, October 1, 1963–September 30, 1964. Norwood, J. M.; Beissner, R. E. (General Dynamics/Fort Worth, Tex.). Mar. 1965. Contract AF29 (601)-6213. 85p. (FZK–201; WL-TR–64-151). CFSTI $3.00 cy, $0.75 mn.

Studies were made to develop new and improved computational models for the determination of radiation intensity behind bulk shields and to provide further insight into radiation transport phenomena. A study of integral transform methods as applied to the neutron transport equation in finite geometrics under the spherical harmonics formulation is presented; representative problems are treated in slab, spherical, and cylindrical geometries. A matrix-integral-operator solution in slab geometry is included. The results of a study of an asymptotic method of obtaining angular distributions behind bulk shields are presented and the problem of electron transport in the 1- to 5-Mev range is discussed. (auth)

1304 (AE–196) MEASURED AND PREDICTED VARIATIONS IN FAST NEUTRON SPECTRUM WHEN PENETRATING LAMINATED Fe–D_2O. Aalto, E.; Sandlin, R.; Fraeki, R. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Sept. 1965. 20p. Dep. mn.

Variations of the fast neutron spectrum in thin regions of alternating Fe and D_2O were studied using threshold detectors (In(n,n'), S(n,p), Al(n,α)). The results were compared to those calculated by two shielding codes (NRN and RASH D) of multigroup removal-diffusion type. The absolute fast spectrum was found to agree with measurements within the same accuracy (a factor of two) as did the thermal flux. The calculated spectrum is slightly harder than the measured one, but the detailed variations (covering the range 1:5) in the form of the spectrum when penetrating Fe agree with observations to within 15-20%. In and Al activities were found to be proportional to the integrated flux over 1 Mev throughout the whole configuration, while S showed the least proportionality. (auth)

1305 (AED–C–01-10) STRAHLENABSCHIRMUNG TEIL V. REIHE C. (Radiation Shielding, Part V. Series C). (Fraunhofer-Gesellschaft, Stuttgart (West Germany)). 1965. 132p. Dep. mn.

References (with German Abstracts) are presented of articles on radiation shielding which were published in journals. The references are arranged alphabetically by journal, in chronological sequence. Author and subject indexes are included. (D.L.C.)

1306 (NASA-TM-X-1140) MEASUREMENTS OF BREMSSTRAHLUNG PRODUCED BY 0.75 AND 1.25 Mev ELECTRONS INCIDENT ON TYPICAL APOLLO WALL SECTIONS. Hendricks, Herbert D.; James, Thomas G. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center); York, Larry B. (National Aeronautics and Space Administration, Houston, Tex. Manned Spacecraft Center). Sept. 1965. 28p. CFSTI $2.00 cy, $0.50 mn.

Typical Apollo wall sections were irradiated with 0.75 and 1.25 Mev electrons from an electron accelerator. The intensity and angular distribution of the bremsstrahlung produced in and attenuated by the wall sections were measured. The maximum dose rates are received through the thinnest wall sections. The maximum dose rate and bremsstrahlung intensity from all wall sections are always greatest in the direction of the electron beam and decreases sharply on each side of the beam. Bremsstrahlung spectra show a maximum photon intensity at energies between 80 and 115 kev and a greater intensity of high-energy bremsstrahlung photons from 1.25 Mev electrons than from 0.75 Mev electrons. (auth)

1307 (RRA–M45) SIMPLIFIED METHODS FOR CALCULATING THE PENETRATION OF NEUTRON AND GAMMA RADIATION INTO UNDERGROUND CONCRETE STRUCTURES. Collins, D. G.; French, R. L.; Mooney, L. G.; Tompkins, K. W.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Nov. 25, 1964. Contract W-7405-eng-26; Subcontract 2267. 34p. (CONF-654–95). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From American Nuclear Society Meeting, San Francisco, Nov.–Dec. 1964.

The analysis of two experiments provides a basis for the development and evaluation of simplified methods for predicting the prompt weapons radiation intensities inside underground concrete structures. One experiment mapped the radiation inside two concrete bunkers with an interconnecting tunnel located in a hillside approximately 700 feet from the source. The other experiment mapped the radiation in concrete-lined cylindrical holes at distances of 100, 228, and 450 feet from the reactor. In both experiments the openings of the underground structures were shielded with various thicknesses of concrete. Albedo methods were developed for calculating neutron and gamma-ray reflection from the concrete walls of the structures and for calculating gamma dose rates due to thermal neutrons captured in the walls. Penetration calculation methods which consider the energy and angular distributions of the incident and emergent radiations were also developed. Most of the simplified methods are based on systematization of Monte Carlo data. Except for the problem of predicting thermal neutron fluxes for use in secondary gamma calculations, the overall calculational approach appears adequate. (auth)

1308 (RRA–T41) PENETRATION OF NEUTRON AND GAMMA RADIATION THROUGH THE OPENINGS OF UNDERGROUND STRUCTURES. French, R. L.; Wells, M. B.; Schaeffer, N. M. (Radiation Research Associates, Inc., Fort Worth, Tex.). Nov. 30, 1964. Contract W-7405-eng-26; Subcontract 2267. 135p. Dep. mn; CFSTI $4.00 cy, $1.00 mn.

For Oak Ridge National Lab., Tenn.

Calculations were performed of the radiation intensities in open concrete-lined cylindrical holes and in open concrete bunkers due to a fission source located in air at distances of 100 to 700 feet. The calculations are part of an analysis of experiments performed with the Tower Shielding Reactor II (TSR-II) at Oak Ridge National Laboratory which included numerous radiation measurements in the underground structures with and without shields over the openings. The approach followed in the calculations was to determine, from geometric considerations, the portion of the incident radiation intensities which could enter the structures. Methods were developed to account for effects of the air-ground interface and albedo models were devised to simplify calculation of wall-scattering and production of secondary radiation in the walls. In general the calculated and measured data agree within approximately 25 percent. (auth)

1309 (RRA-T46) DIFFERENTIAL DOSE ALBEDOS FOR CALCULATION OF GAMMA-RAY REFLECTION FROM CONCRETE. Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Dec. 30, 1964. Contract W-7405-eng-26; Subcontract 2267. 55p. Dep. mn; CFSTI $3.00 cy, $0.50 mn.

For Oak Ridge National Lab., Tenn.

Differential dose albedos for gamma ray reflection from concrete were derived from Monte Carlo calculations of gamma ray scattering in air and concrete for source energies of 0.6, 1, 2, 4, and 7 Mev. Curves showing the albedo for reflection in the plane of incidence are presented for angles of incidence of $\theta_0 = 0$, 30, 45, 60, and 75°. At incident energies greater than 2 Mev the computed dose albedos are smaller than those reported by Raso (also based on Monte Carlo) and those given by the Chilton-Huddleston formula. However, comparisons with experimental data for ^{137}Cs and ^{60}Co gamma rays reported previously indicate that the calculated albedos for these sources agree as well with the experimental data as do calculations based either on the Chilton-Huddleston formula or Raso's Monte Carlo calculations. (auth)

1310 (RRA-T51) NEUTRON AND GAMMA RADIATION PENETRATION INTO CONCRETE-SHIELDED UNDERGROUND STRUCTURES. French, R. L.; Wells, M. B.; Schaeffer, N. M. (Radiation Research Associates, Inc., Fort Worth, Tex.). May 31, 1965. Contract W-7405-eng-26; Subcontract 2267. 141p. Dep. mn; CFSTI $4.00 cy, $1.00 mn.

For Oak Ridge National Lab., Tenn.

The fast-neutron and gamma-ray dose rates in concrete-shielded and concrete-lined cylindrical holes and bunkers located at distances of 100 to 700 feet from the ORNL Tower Shielding Reactor (TSR-II) were computed and compared with measured dose rates. The calculations, which in most cases agree within 25% with the measurements, show the relative importance of the various radiation components including direct-beam, shield-scattering, wall-scattering, and secondary gamma rays. Wall-scattering was found to contribute up to 40% of the fast-neutron dose rate at positions deep inside the structures. Thermal-neutron capture in the concrete shields accounted for as much as 90% of the gamma-ray dose rates for thick shields. Capture gamma rays produced in the walls of the cylindrical holes and bunkers were also important in many cases. Simplified methods were developed for computing most of the radiation components. These methods are applied to a cylindrical hole with laminated iron and concrete shields. (auth)

1311 (RT/FIMA(65)2) SUI FATTORI DI ACCUMULAZIONE DEL CALCESTRUZZO: COEFFICIENTI DELLA RAPPRESENTAZIONE POLINOMINALE. (On the Build-up Factors for Concrete: Coefficients of the Polynomial Representation). Buscaglione, S.; Manzini, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). June 1965. 11p. Dep. mn.

Bivariant polynomial coefficients of dose buildup factors for gamma rays, for a point isotropic source, were derived for ordinary magnetite ferrophosphorus, and barite concretes. (auth)

1312 RESEARCH ON CONCRETE STRUCTURES IN NUCLEAR ENGINEERING. Lee, C. R. Concrete and Constr. Eng., 60: 195-8(May 1965).

Studies made on the behavior of concrete structures in nuclear engineering in England are summarized. Investigations were made under three headings: studies of the basic properties of concrete and steel and of the behavior of concrete members; studies of the behavior of concrete shields by means of scale models; and studies of behavior on the full-scale by observations on actual structures. (P.C.H.)

1313 GAMMA-RAY ATTENUATION BY LOBLOLLY PINE WOOD: AN INVESTIGATION OF INTEGRAL COUNTING. Woods, Frank W.; Hough, Walter A.; O'Neal, Denny; Barnett, James (Duke Univ., Durham, N. C.). Forest Sci., 11: 341-5(Sept. 1965).

This study was made to determine attenuation values of γ rays for loblolly pine wood for selected low energies and whether integral counting will produce acceptable attenuation values. Wood block absorbers were cut from basal sections of two loblolly pines (Pinus taeda) to minimize the variation in wood density. A sealed 40-μC source of ^{131}I was used as the source of γ photons. A narrow beam of photons was obtained by collimation through a hole in a lead brick. Radiation was detected with a NaI (Tl) phosphor and photomultiplier and counts were recorded by either a Packard single channel analyzer or a Nuclear-Chicago portable scaler. Measurements of γ-ray attenuation were made using wood blocks of different thicknesses over the moisture content range from total saturation to oven dry. Within limits, attenuation by pine wood by either integral or differential counting was equally satisfactory. Because the former requires simpler equipment and is more adapted to field work, it was further explored. Linear attenuation coefficients were measured for the wood (sp gr 0.485 g/cm^3) at various moisture contents, as well as half-thickness values and mass attenuation coefficients calculated for each moisture content. Results indicated that the wood has a mass attenuation coefficient very similar to that of water, greater than that of concrete or aluminum, and smaller than that of lead or tin. Half-thickness values are about twice as high for over dry wood as for water. However, at a moisture of 50 to 60% (by volume), wood has a half-value almost identical to that of water. At this moisture content about 6 cm of wood between the detector and a point source will reduce the count rate by half. (BBB)

1314 TESTING OF MATERIALS FOR RADIATION PROTECTION AGAINST X AND GAMMA IRRADIATION. DIN 6845. (Fachnormenausschuss Radiologie, Hamburg). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 102: 335-7(Mar. 1965). (In German).

This report states formal requirements for testing of materials for their radiation protection against x irradiation up to an energy of 3 Mev and for γ irradiation from radioactive materials. The test report should contain results of measurements, weight, and other characteristics of the material tested. If possible, its commercial name and composition should be given. The relation between radiation attenuation and mass for broad and narrow irradiation beams should be stated. Effects of variations in irradiation parameters, including tube voltages from 80 to 400 kv and Cu filtration from 0.2 to 3.8 mm, should be measured for x irradiation. Attenuation of γ irradiation from ^{192}Ir, ^{137}Cs, and ^{60}Co should be measured. Dosimeters used for these measurements should be energy independent between 40 kev and the maximal energy used, within ±20%. Depth and diameter of the sensitive volume should not be greater than 5 cm. For Pb equivalent measurements the test material size should not exceed a size of 10 × 10 cm. A narrow irradiation beam should be used. The thickness of the test sample, the irradiation quality used, and the Pb equivalent values found should be included in the report. The Pb equivalent of materials intended for use in protective clothing should be evaluated according to criteria specified in other publications of this series. To test homogeneity the attenuation or Pb equivalent value must be evaluated by 5 to 10 x-ray exposures in various positions,

using a specified irradiation quality. The irradiation beam should have a dia of 1 cm on the side of the test sample closest to the irradiation source, and it should illuminate the detector directly. The test sample should have a total surface of at least 100 cm^2. The error valuability of each parameter measured must be specified. (BBB)

1315 THE EXISTENCE AND UNIQUENESS OF THE SOLUTION TO A PROBLEM IN INVARIANT IMBEDDING. Brown, T. A. (Rand Corp., Santa Monica, Calif.). J. Math. Anal. Appl., 11: 236-41(July 1965).

The existence and uniqueness of a solution to a system of nonlinear ordinary differential equations arising from the invariant-imbedding approach to the problem of transport processes in a one-dimensional rod are established. (D.C.W.)

1316 MEASUREMENTS OF DOSE BUILD-UP FACTORS OF IRON SLABS FOR A LINE ISOTROPIC SOURCE. Umeda, Iwao (Nippon Kokan Co., Japan). Nippon Genshiryoku Gakkaishi, 7: 480-4(Sept. 1965). (In Japanese).

Dose build-up factors were obtained for transmitted γ rays from an infinite line isotropic source through an infinitely extensive slab placed in parallel with the source. In the measurements, an alternative arrangement was adopted, giving results equivalent to the line isotropic geometry with a point isotropic source (about 1 C ^{60}Co and ^{137}Cs), an air equivalent cylindrical ionization chamber, and iron plates. Up to 1 mean free path slab thickness, the dose build-up factor of the combination of infinite line isotropic source with infinitely extensive iron slab was the same as that with infinite iron medium. For thicknesses of 1 to 3 mean free paths, it was smaller with the former combination by about 7%. In excess of 3 mean free paths, the dose build-up factor of a point isotropic source in an infinite iron medium can be used instead of the infinite line source—infinite slab combination without causing errors beyond 5%. (auth)

1317 MEASURED AND PREDICTED THERMAL- AND FAST-NEUTRON FLUXES IN AIR-FILLED ANNULAR DUCTS. Nilsson, J.; Sandlin, R. (AB Atomenergi, Studsvik, Sweden). Nucl. Sci. Eng., 23: 224-33(Nov. 1965).

An investigation was carried out concerning the transmission of thermal and fast neutrons in air-filled annular ducts. A calculational model to predict the air-gap flux is developed and fitted to the results from foil-activation experiments in a Fe–D_2O configurations, the duct length being about half a meter and the annular air gaps varying from 0.5 to 2.0 cm. It is based upon the condition that the flux is theoretically and experimentally divided into uncollided and collided components for both thermal and fast neutrons. The model may be applied to most of the straight annular ducts that occur in reactor shielding, but it is especially designed for the problems met with in short ducts. (auth)

1318 MEASURED AND PREDICTED VARIATIONS IN FAST NEUTRON SPECTRUM IN MASSIVE SHIELDS OF WATER AND CONCRETE. Aalto, E.; Fraeki, R.; Sandlin, R. (Aktiebolaget Atomenergi, Stockholm). Nucl. Struct. Eng., 2: 233-42(1965).

The absolute magnitude, and the variations in form, of the fast neutron spectrum during deep penetration (0.8–1.1 m) in massive shields of water and ordinary and magnetite concrete were studied by using threshold detectors (In(n,n'), S(n,p), Al(n,α)). The results were compared with predictions by two rigorous (NIOBE, Moments method) and two non-rigorous (multigroup removal-diffusion)shielding codes (NRN, RASH D). The absolute results predicted were in general within 50% of the measured ones, i.e. showed as good or better accuracy than thermal and epithermal flux predictions in the same small-reactor configurations. No difference in accuracy was found between the rigorous and non-rigorous methods. The changes in the relative form of the spectrum (indicated by variations in the (Al/S) and (In/S) reaction rate ratios and amounting to factors up to 3–4 during a one metre penetration in water) were rather accurately (within 10–30%) predicted by all of the methods. The photonuclear excitation of the 335-kev level used for detecting the In(n,n') reaction was found to distort completely the In results in water at penetrations >50 cm. (auth)

1319 METHOD FOR WEIGHT OPTIMIZATION OF A TWO-MATERIAL SHIELD FOR REACTOR RADIATION. Sasse, S. (Technische Hochschule, Hannover). Nucl. Struct. Eng., 2: 327-34(1965).

Method of analysis of the problem of designing a homogeneous two-material spherical reactor shield of minimum weight, treating radiation attenuation in plane geometry is discussed. The optimization procedure is illustrated by the outline of an example calculation for a reactor shield consisting of a hydrogeneous material (organic plastic) loaded with lead where the space-variable volume fraction of lead is optimized to give a shield of minimum overall weight. (auth)

1320 TRANSMISSION OF GAMMA RAYS THROUGH PIPE WALLS. Umeda, Iwao (Technical Research Inst., Kawasaki, Japan); Hyodo, Tomonori. Nucl. Struct. Eng., 2: 335-40(1965).

Transmission of gamma rays from ^{60}Co and ^{137}Cs line isotropic sources through a steel pipe wall was measured as a function of the wall thickness. The measurement was carried out with two alternative arrangements: a point isotropic source and a long cylindrical ionization chamber, and also a moving point isotropic source on the pipe axis and a small spherical ionization chamber. Comparing the build-up factor obtained by this experiment with that for similar geometry calculated from the results obtained by Goldstein and Wilkins for an infinite homogeneous medium using the method of moments, the ratio of the former to the latter was 0.90 for ^{60}Co and 0.87 for ^{137}Cs, respectively, for the wall thickness larger than 1.5 cm. (auth)

1321 THE THEORY OF THE MULTIPLE SCATTERING OF γ RADIATION IN EXPANDED SCATTERING MEDIA. PART I. Schaarschmidt, Alfred (Johann-Wolfgang-Goethe-Universitaet, Frankfurt am Main). Z. Angew. Physik., 19: 180-7(1965). (In German).

A survey of the principles of the theory of multiple scattering of γ radiation in expanded scattering media of small atomic number is given for the energy region in which the pair formation plays no role. A three group distribution of the radiation is possible: true primary radiation, hard forward scattered quasi-primary radiation which determines the penetration at great layer depth, and diffuse low-energy scattered radiation of low range. The pattern of the scattering spectra under the primary radiation is described through a straightforward solution, but under the utilization of the Wicks eigenvalues; this approximation is, as the comparison with the spectra of Goldstein and Wilkins for water shows, often more valid for a perpendicular radiating surface than for a point source. For the spectral distribution in the low-energy range, approximated as scattering spectra at spatially equally distributed sources, a representation deviating from the formula of Fano and Nelms was used; the different approximations were evaluated for pure Compton scatters (H_2O, Al, and Fe) and compared with the numerical solutions of the pertinent integral equation. Combining the solutions for the upper and lower energy range, the total field of the scattering spectra was constructed using water as the scattering medium at E_0 = 1 Mev. (tr-auth)

1322 THE THEORY OF MULTIPLE SCATTERING OF γ RADIATION IN EXPANDED SCATTERING MEDIA. PART II. Schaarschmidt, Alfred (Johann-Wolfgang-Goethe-Universitaet, Frankfurt am Main). Z. Angew. Physik., 19: 187-93(1965). (In German).

As a further approximation for the field of the scattering spectra under the assumption of known patterns of construction factors in dependence on the distance, the ideal equilibrium spectra is introduced and compared with the spectra of Goldstein and Wilkins for Al at E_0 = 1 Mev. The further propagation of the scattering radiation in the low-energy region is then discussed on the basis of an age cal-

culation and a stationary diffusion calculation for Al as a scattering medium at E_0 = 1 Mev in various approximations with respect to the anisotropy of the scattering and absorption. By consideration of the dependence of the differential cross section of the wave length before the scattering, the Fermi age was formally expanded to γ quanta. The calculation is carried out with the Flugg approximation of a spatially distributed source which was simulated by utilization of the Taylor representation for the construction factor through the sum of three exponental functions. The effect of diffusion of the quanta was, as the evaluation shows, in comparison with the spectra of Goldstein and Wilkins, still valid with respect to the sign although the contribution was too strongly represented. The numerically calculated spectra lie in the low-energy region between the ideal equilibrium spectra and the diffusion spectra. The calculations show that with the model calculation used, at still significant calculation expenditure, a good description of the scattering spectra can be obtained. (tr-auth)

1323 RADIATION SHIELD FOR A NEUTRON SOURCE. (to United Kingdom Atomic Energy Authority). French Patent 1,343,522. Oct. 14, 1963. Priority date June 26, 1961, Great Britain.

A radiation shield for a neutron source comprises a liquid retaining capacity arranged between the source and a radiation facility, a supply of liquid having a large absorption cross section for neutrons and means for passing the liquid between the supply and the liquid retaining capacity. Ducts are provided intercommunicating a supply tank with said capacity, the supply tank being arranged at such a level that in the event of pump failure the capacity is filled from the supply tank by gravity. (IIB)

Solid State Physics

See also CHEMISTRY — Inorganic and Physical Chemistry
METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure

1324 (EURAEC–1428) DIFFUSION OF RARE GASES IN SOLIDS. Quarterly Report No. 20, April–June 1965. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). July 1965. Contract 028-64-1 TEE. 22p. (EUR–2371). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The evolution of rare gases from UO_2 monocrystals in vacuo above 1500°C is determined by evaporation. For the Xe diffusion in UC monocrystals, D-values were determined between 1300 and 1930°C. With considerable scattering, Q was estimated at 86 kcal/mol and D_0 at 10^{-2} to 10^{-4} cm^2sec^{-1}. The Arrhenius equation of ^{37}Ar diffusion in CaO crystals was found to be: D = 0.55 exp (–81500/RT). For the effect of temperature on the T-diffusion in an Ag–Li alloy, the following mechanism was considered as probable. On account of hydrogen oversaturation, an internal separation takes place, which is supposed to be one of molecular hydrogen. According thereto there are three distinct energetic states of hydrogen inside the sample: (1) internal separation (lowest energetical state), (2) on intermediate lattice spots, (3) mobile (= capable of changing places inside the lattice). Hence, the activation energy which was noticed in the upper temperature range should be described as place-changing energy (transition from (2) to (3)), whilst the largest activation energy in the lowest temperature range should mainly be ascribed to a solution of the separated hydrogen in the crystal. (auth)

1325 (NP–15453) K TEORII MIGRATSII ENERGII ELEKTRONNOGO VOZBUZHDENIYA MOLEKULYARNYKH KRISTALLAKH [thesis]. (On Theory of Electron-Excitation Energy Migration in Molecular Crystals [thesis]). Konobeev, Yu. V. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 114p. Dep. mn.

The development of the phenomenological theory which takes into account the fact that in molecular crystals the energy migration may be achieved by the migration of excitons and through the action of luminescence photons is reviewed. A solution is given for the integral-differential equations concerning the exciton density originally developed by A. M. Samson (Inzh. Fiz. Zhur. 1: No. 1(1958)) for any exciton diffusion coefficient and for any overlap of emission and absorption spectra in molecular crystals. The solution obtained is valid for plane crystal layers of any given thickness for both stationary and nonstationary excitation of the crystal by a light beam of any frequency. The equations make it possible to calculate the technical quantum yield and the extinction of the luminescence. By generalizing V. A. Ambartsumyan's method (Astronom. Zhur. 19: 30(1942)), the reflection of the light on the internal surfaces of the crystals is also taken into account. For phosphors which have a small coefficient of exciton migration, the effect of the reabsorption of light in the case of photon-type mechanism of energy migration has been clarified on the basis of their absorption and emission spectra. These results may be applied for any molecular medium and also for the transfer of light energy in the atmosphere of the stars and planets. The problem of the diffusion length of free and localized excitons was also studied. It is concluded that the divergence between experimental and theoretical values may be due to the effect of localized excitons or to crystal defects. (TTT)

1326 (ORNL–P–1600) STUDIES OF COLLECTIVE ELECTRON OSCILLATIONS IN METALS BY OPTICAL METHODS. Arakawa, E. T.; Hamm, R.N.; Hanson, W. F.; Jelinek, T. M. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 23p. (CONF-650929-2). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Conference on Optical and Electronic Properties of Metals and Alloys, Paris.

Reflection of photons from opaque solids and photon emission from electron-bombarded thin films were investigated to determine the plasma frequencies of free electrons in various metals, e.g., Al, Cd, Tl, and Zn. The energy loss functions for volume and surface plasmons were calculated from the optical constants determined from reflectivity measurements, and were compared with the results obtained in energy-loss experiments. Unambiguous identification of the plasma losses was made possible by a knowledge of the optical constants, since these losses arise at frequencies where certain types of peaks are found in the energy loss functions. Studies of photon emission from electron-bombarded thin films give information not only on the volume plasma frequency, but also on lifetimes of the plasma oscillations due to radiation and to electronic damping. (auth)

1327 ROTATIONAL SPECTRA OF TlF BY THE MOLECULAR BEAM ELECTRIC RESONANCE METHOD. Ritchie, R. K.; Lew, H. (National Research Council, Ottawa). Can. J. Phys., 43: 1701-5(Oct. 1965).

The rotational constants for ^{203}TlF and ^{205}TlF were calculated from measurements of the J = 1 ← J = 0 transitions in TlF by the molecular beam electric resonance method. The internuclear distance for both isotopic species was calculated to be 2.08442 ± 0.00009Å, and the $^{203}Tl/^{205}Tl$ mass ratio was calculated to be 0.990240 ± 0.000020. (D.C.W.)

1328 THE EFFECT OF PRESSURE ON THE FERROMAGNETIC PHASE TRANSITION OF EuO. Stevenson, Richard; Robinson, M. C. (McGill Univ., Montreal). Can. J. Phys., 43: 1744-9(Oct. 1965).

The compressions of EuO up to 10,000 atm were measured at 296, 82, and 4.2°K. The shift in temperature of the ferromagnetic phase transition was measured as a function of pressure by measuring the mutual inductance of a coil containing the solid. The transition occurs at

about 72°K at 10,000 atm, which is about 5°K higher than the transition at atmospheric pressure. The results tend to substantiate the molecular field model for EuO proposed by McGuire and Shafer. An estimate is made of the variation of the exchange interaction parameter with lattice parameter, $\Delta J_1/\Delta a = -0.62°K/Å$, where J_1 refers to interactions between nearest magnetic neighbors. (auth)

1329 REDUCED MATRIX ELEMENT OF AN IRREDUCIBLE SPHERICAL TENSOR OPERATOR. NEW DERIVATION AND APPLICATIONS. Fox, Kenneth (Univ. of Tennessee, Knoxville; Oak Ridge National Lab., Tenn.). J. Mol. Spectros., 17: 247-51(Aug. 1965).

A new derivation is given of the result that the reduced matrix element of an irreducible spherical tensor operator $T(kq)$ is $(\gamma J||T(k)||\gamma J) = [(2J + k + 1)!k!/(2J - k)!(2k - 1)!!]^{\frac{1}{2}} [f(J)]^k$, where $f(J) = [(2J)(2J + 1)(2J + 2)]^{-\frac{1}{3}}(\gamma J||T(1)||\gamma J)$; the reduced matrix is assumed diagonal in γ and J. Applications of this result to problems of molecular structure and spectroscopy and solid state physics are discussed. These are cases in which high order polynomials in angular momentum operators make the use of the irreducible spherical tensor formalism advantageous. (auth)

1330 THE EFFECT OF ANTIFERROMAGNETISM ON THE DENSITY OF STATES OF CHROMIUM AND ITS ALLOYS. Heiniger, F.; Bucher, E.; Muller, J. (Univ., Geneva). Phys. Lett., 19: 163-5(Oct. 15, 1965).

The Néel temperatures, specific heats, and Debye temperatures of chromium-based alloys were investigated as a function of concentration. An indication of the magnitude of the change of the electron density of states at the Fermi surface of chromium due to the antiferromagnetic transition was obtained from a study of the correlation between the Néel temperatures and specific heats of the chromium-based alloys with transition metals. (D.C.W.)

1331 ANGULAR DEPENDENCE OF ELECTRON-PENETRATION IN MONOCRYSTALLINE COPPER. Bell, F.; Sizmann, R. (Univ., Munich). Phys. Lett., 19: 171-2(Oct. 15, 1965).

The yield of the K-line emission was measured as a function of the tilting angle between the (110) axis of a single crystal of copper and an incident electron beam of about 10 kev. Evidence for the anisotropic penetration of the electrons was observed. A reduction of nearly 40% in the yield corresponding to a beam direction parallel to the 110 orientation of the crystal was noted. (D.C.W.)

1332 RESISTIVITY AND MAGNETIC SUSCEPTIBILITY OF CERIUM NITRIDE AT LOW TEMPERATURE. Anselin, F.; (Centre d'Etude Nucleaires de Fontenay-aux-Roses, France); Lorenzelli, N.; Lallement, R.; Veyssie, J. J. Phys. Lett., 19: 174-5(Oct. 15, 1965). (In French).

The electric resistivity and magnetic susceptibility of cerium nitride were measured between 4.2 and 300°K. The results show that cerium nitride is not magnetically ordered at low temperatures and that the paramagnetism of cerium nitride is due to Ce^{3+} ions. (D.C.W.)

1333 DIELECTRIC PROPERTIES OF PARTIALLY DEUTERATED $NaH_3(SeO_3)_2$ SINGLE CRYSTALS. Blinc, R.; Vovk, D. (Nuclear Inst. J. Stefan, Ljubljana, Yugoslavia). Phys. Lett., 19: 177-8(Oct. 15, 1965).

The dependence of the dielectric properties and ferroelectric transition temperatures of partially deuterated $NaH_3(SeO_3)_2$ single crystals on the concentration of deuterium was investigated. Qualitatively, the dependence of the transition temperatures on the deuterium content can be predicted by the theoretical expression of Janovec for an ideal solid solution of two isomorphous ferroelectric crystals. (D.C.W.)

1334 AXIAL AND PLANAR EFFECTS IN THE ENERGY LOSS OF PROTONS IN SILICON SINGLE CRYSTALS. Appleton, B. R. (Rutgers, Univ., New Brunswick, N. J.); Erginsoy, C.; Wegner, H. E.; Gibson, W. M. Phys. Lett., 19: 185-6(Oct. 15, 1965).

The energy spectra of protons transmitted by single crystal of silicon were measured. The angle of incidence of the beam was varied to vary the thickness of the crystal exposed. Spectra were also obtained for beam incidence directly along crystal planes. The results show that planar effects exist independently of any axial effect and that, for large thicknesses, the fraction of the beam that is subjected to pure axial channeling is small even when incidence is along a crystal axis. (D.C.W.)

1335 MOESSBAUER EFFECT IN ^{119}Sn: INTERPRETATION OF ISOMER SHIFTS AND QUADRUPOLE SPLITTINGS OF STANNOUS COMPOUNDS. Lees, J.; Flinn, P. A. (Carnegie Inst. of Tech., Pittsburgh). Phys. Lett., 19: 186-8(Oct. 15, 1965).

The Mössbauer spectra of a number of tin compounds were measured, and isomer shifts and quadrupole splittings were obtained by an iterative least squares fitting of the experimental data to a sum of Lorentz peaks. According to a plot of isomer shifts vs quadrupole splittings, the compounds appear to belong to two distinct families; the points for each family can be fitted by a straight line. An interpretation of the observations is outlined. (D.C.W.)

1336 HEAT CAPACITY AND OTHER PROPERTIES OF HEXAGONAL CLOSE-PACKED ^4He. Edwards, D. O.; Pandorf, R. C. (Ohio State Univ., Columbus). Phys. Rev., 140: A816-25(Nov. 1, 1965).

The heat capacity of hcp helium was measured for six molar volumes from 20.9 to 16.9 cm^3 between about 0.3°K and the melting point. The calorimeter, which uses magnetic cooling and thermometry, is described in some detail. The results, expressed as Debye thetas, level off at low temperatures to constant values, θ_0. The volume dependence of θ_0 gives a Grüneisen constant of 2.60 ± 0.05. The temperature dependence of θ, which is not qualitatively different from that found in other solidified inert gases, is such that θ/θ_0 is a single function of T/θ, irrespective of density. The results were used with melting-curve data to give the internal energy, entropy, compressibility, and expansion coefficient. The values of the compressibility are in agreement with those obtained from the discontinuity in the heat capacity on melting. Comparison of θ_0 with the compressibility and velocity-of-sound data indicates that hcp helium is elastically anisotropic but approximately obeys the Cauchy relations. (auth)

1337 EXCITED STATES OF SOLID Ar:H. II. LINE SHAPES AND INTERSTITIAL SITES. Keil, Thomas H.; Gold, Albert (Univ. of Rochester, N. Y.). Phys. Rev., 140: A906-10(Nov. 1, 1965).

The line shape of the 1s-2p transitions of substitutional H and D atoms in solid argon was analyzed on the basis of a "four-mode model." The impurity is treated as interacting (semiclassically) with a linearly coupled "breathing mode" and with three localized quadratically coupled modes. A full quantum-mechanical treatment of the latter is essential. The experimentally observed isotope shift of the peak is fitted and part of the isotopic width change accounted for by this model. Local-mode infrared absorptions at 0.033 and 0.023 ev are predicted for Ar:H and Ar:D, respectively. It is shown that the relatively high concentration of H (or D) impurities used (~2%) simultaneously accounts for the additional width change and the low-energy tail of the spectrum. Excitation energies for the 1s-2p transitions of H atoms trapped at octahedral or tetrahedral interstitial sites are computed using a tight-binding model which was previously used to predict the excitation energy for the substitutional site. Within computational accuracy the transitions are found to take place at the same energy as that for substitutional atoms. Although it seems unlikely that interstitials are present in Baldini's work (here analyzed), experiments to verify their absence are suggested. Experimental measurement of the concentration dependence of the linewidths and the intensity of the low-energy tail will provide useful checks of the model. (auth)

1338 CERIUM MAGNESIUM NITRATE TEMPERATURE SCALE FROM NUCLEAR ORIENTATION. Frankel, R. B.; Shirley, D. A.; Stone, N. J. (Univ. of California,

Berkeley). Phys. Rev., 140: A1020-3(Nov. 1, 1965). (UCRL-16012).

Systematic deviations were found below 0.003°K in the temperature dependence of nuclear orientation of ^{137m}Ce in cerous magnesium nitrate, using the temperature scale proposed by Daniels and Robinson. The temperature scale below 0.006°K was redetermined using a new method: nuclear orientation. This has the advantage over the γ-ray heating method of high sensitivity at the lowest temperature. The most striking result is that a value of 1/T of 520, rather than the previously accepted 324, is obtained by demagnetization from initial conditions of 18.8 kG deg^{-1}. The useful absolute temperature range is thus extended by at least 60% in 1/T. Auxiliary experiments on oriented ^{144}Pm gave similar results and provided independent confirmation both of the inadequacy of the old temperature scale and of the validity of the new one. (auth)

1339 ISOTOPE SHIFT OF A LOW-LYING LATTICE RESONANT MODE. Sievers, A. J.; Takeno, S. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 140: A1030-?(Nov. 1, 1965). (NYO-2391-10).

A sharp and very low-frequency lattice absorption due to a lithium resonant mode was found in KBr: LiBr. A large frequency shift with lithium isotopes was observed. The experimental results can be understood with a simplified lattice model in which both nearest-neighbor force constants and the mass of the impurity are varied. It is concluded that the resonant mode comes from a remarkable softening of the forces between the impurity and the surrounding lattice. (auth)

1340 CRYSTAL STRUCTURE OF NORMAL HYDROGEN AT LOW TEMPERATURES. Mills, R. L.; Schuch, A. F. (Univ. of California, Los Alamos, N. Mex.). Phys. Rev. Lett., 15: 722-4(Nov. 1, 1965). (LA-DC-7457).

The crystal structure of normal hydrogen at liquid-helium temperatures was investigated by x-ray diffraction. The structure is hexagonal-close-packed from 4°K to about 1.3°K, changing to face-centered-cubic below this temperature. The transition temperature was found to decrease with decreasing ortho-para ratio. (D.C.W.)

1341 THE THERMODYNAMIC AND VIBRATIONAL PROPERTIES OF H_2O ICE AND D_2O ICE. Leadbetter, A. J. (Univ., Bristol, Eng.). Proc. Roy. Soc. (London), Ser. A, 287: 403-25(Sept. 14, 1965).

The thermodynamic properties of H_2O ice and D_2O ice were analyzed in terms of the effective harmonic spectrum of lattice vibrations. In this approximation the vibrations are treated as harmonic, but with frequencies which are both volume and temperature dependent. Analysis of the heat capacity then gives properties of the effective spectrum at 0°K and the average temperature dependence of the spectrum at constant volume. It was shown that the parts of the spectrum associated with translational and librational motion of the molecules are distinct and that their contributions to the thermodynamic properties may be separated. The moments $\bar{\nu}^{-2}$, $\bar{\nu}^{-1}$, $\bar{\nu}$, $\bar{\nu}^2$, $\bar{\nu}^4$ and $\bar{\nu}^6$ together with the geometric mean frequency ν_g, were derived for the separate parts of the spectrum. The reduced librational moments, $(\bar{\nu}^n)^{1/n}$, are independent of n within the experimental uncertainty. This shows that the spectrum of librational frequencies consists of a fairly sharp and symmetrical band. From the very low temperature data the coefficients of the terms in ν^2, ν^4 and ν^6 in the low-frequency expansion of the translational spectrum were derived, together with the position and approximate weight of the first peak in the spectrum. The ratios of the moments for H_2O and D_2O show that the intermolecular forces are stronger for D_2O than for H_2O. From the thermal expansion data, by analyzing the Grüneisen function $\gamma(T,V) = \beta V/\chi_s C_p$, values for some of the parameters $\gamma(n) = -(1/n)d\ln\bar{\nu}^n/d\ln V$, which describe the volume dependence of the moments were obtained for the separate parts of the spectrum. These are useful in estimating the volume dependence of various crystal properties. The properties of the effective harmonic spectrum and its average total temperature dependence (including thermal expansion effects) are in good agreement with the results of a variety of spectroscopic experiments. The moments derived from the thermodynamic data were used to calculate the mean square amplitudes of vibration of O, H, and D atoms, and the results are in good agreement with the results of x-ray and neutron scattering experiments. (auth)

1342 ELECTRON-NUCLEAR WAVE FUNCTIONS IN MULTIPHONON PROCESSES. II. EINSTEIN'S A AND B COEFFICIENT IN THE PRESENCE OF A STOKES' SHIFT. Markham, Jordan J. (Illinois Inst. of Tech., Chicago. Johann Wolfgang Goethe-Univ., Frankfurt am Main). Z. Phys., 188: 139-53(1965). (TID-21567)

The equation of detailed balance is set up for an imperfection which exhibits a large Stokes' shift and hence interacts strongly with the lattice. Terms for multiphonon transitions are added to the usual equation due to Einstein. It is proved that, in general, the multiphonon terms will be exactly equal and that they will cancel out from the balance equation. Using the equation of detailed balance, a new expression for the lifetime is obtained which indicates that an additional term appears in the relation of the oscillator strengths for absorption and emission. It indicates why one can not calculate the lifetime of the excited state of say an F-center from the absorption and emission measurements alone. To establish these relations, the Hamiltonians associated with the Born-Oppenheimer technique are explored further than previously, and some new relations are obtained. (auth)

1343 SEEBECK EFFECT IN HEAVY RARE EARTH SINGLE CRYSTALS [Thesis]. Sill, Larry Robert. Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 140p.

Seebeck coefficients, S, (thermopowers) were measured along the three crystallographic directions $\langle 11\bar{2}0\rangle$, $\langle 10\bar{1}0\rangle$, and $\langle 0001\rangle$ for Gd, Tb, Dy, Ho, and Er over the temperature range 7 to 300°K. The $\langle 10\bar{1}0\rangle$ and $\langle 0001\rangle$ directions of Y were also measured. In the case of Gd and Tb, the effect on S of a 1000-Oe field along the $\langle 0001\rangle$ and $\langle 10\bar{1}0\rangle$ directions respectively caused no marked change. A significant anisotropy between the $\langle 0001\rangle$ direction and the basal plane was found for all the metals except Y where only a small anisotropy exists. At low temperatures the magnitude of the Seebeck coefficients showed relative maxima which are interpreted in terms of phonon drag. The magnetic order-disorder temperatures are marked by changes in slope in the Seebeck coefficient versus temperature curves. The ferro-antiferromagnetic transition is evident only in the case of Dy and appears as a nearly discontinuous step in the curve. (Dissertation Abstr.)

1344 THE MOESSBAUER EFFECT AT HIGH PRESSURE [Thesis]. Edge, Charles Key. Urbana, Ill., Univ. of Illinois, 1964. 99p.

An apparatus was developed which makes possible the measurement of the Mössbauer effect in metal foils up to a pressure of 250 kilobars. Iron, copper, and titanium were studied using this technique. The isomer shifts of these metals versus pressure were obtained and were interpreted in terms of band theory. The pressure dependence of the magnetic field in iron was also determined up to a phase transition at 130 kilobars. (Dissertation Abstr.)

1345 PHYSICS OF SEMICONDUCTORS. Proceedings of the 7th International Conference, Paris, [July 19-24] 1964. Paris, Dunod, 1964. 1368p. (CONF-679).

Papers (186) are included on band structure, optical properties, magneto-optical effects, transport properties, impurities, free excitons, photoconductivity, phonon-photon interactions, and semiconducting materials. (D.C.W.)

1346 PLASMA EFFECTS IN SOLIDS. 7th International Conference on the Physics of Semiconductors, Paris, July 19-24, 1964. 2. Paris, Dunod, 1965. 221p. (CONF-679).

Papers (25) are included on waves in solid-state plasmas, wave interactions, quantum effects, hot plasmas, and instabilities. (D.C.W.)

1347 NUCLEAR RESONANCE STUDIES OF MAGNETIC CRITICAL FLUCTUATIONS IN MnF_2. Heller, Peter (Brandeis Univ., Waltham, Mass.). 22p. (CONF-650428-3). Gmelin, AED-CONF-65-078-6.

From Conference on Phenomena in the Neighborhood of the Critical Point, Washington, D. C.

The effect of the critical fluctuations on the NMR linewidth is considered. Associated with the approach to the critical temperature the nuclear resonance lines in ferro and antiferromagnets exhibit a remarkably rapid broadening. A very detailed study of this effect was made for the case of the antiferromagnet MnF_2. These experiments shed light on the behavior of the electron spin correlation functions in the critical region. It is shown that the experimental data imply a slowing down of the spin fluctuations in the critical region. A simple physical model for the time dependence of the correlation functions is then presented. This model yields a theory which is in satisfactory accord with the observed broadening of the ^{19}F resonance in MnF_2 as the temperature approaches the critical temperature from above. (J.F.P.)

REACTOR TECHNOLOGY

General

Refer also to abstract 554.

1348 (CONF-650407, pp 1057-70) COMPUTATION OF POTENTIAL RADIOLOGICAL HAZARDS FROM REACTOR ACCIDENTS. Coates, R. L.; Horton, N. R. (Phillips Petroleum Co., Idaho Falls, Idaho).

The selection of sites for nuclear power plants, as well as the design of the plants themselves, must take into consideration the radiological hazards which could exist in the event of a nuclear accident. To provide the degree of flexibility required for a complete parametric study of the radiological hazards, an IBM 7040 computer program was developed which is divided into the following five major categories. I. Curie–Calculates the fission product inventory for any set or series of operating conditions. II. Release and Fractionation–Applies the desired fractionation to Curie and releases the activity to the atmosphere. III. Inhalation–Calculates the internal dose received as a consequence of inhaling airborne radioactive materials. IV. Cloud Gamma–Calculates the external gamma dose received as a consequence of exposure to airborne radioactive materials. V. Deposition Gamma–Calculates the external gamma dose received as a consequence of exposure to deposited radioactive materials. (auth)

1349 (ORNL-TM-1274) A MODEL FOR FISSION PRODUCT TRANSPORT AND DEPOSITION UNDER ISOTHERMAL CONDITIONS. Kress, T. S.; Neill, F. H. (Oak Ridge National Lab., Tenn.). Oct. 1965. Contract W-7405-eng-26. 29p. (CONF-651110-5). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From American Society of Mechanical Engineers, Annual Winter Meeting, Chicago.

The transport of fission products through a carrier coolant stream and their deposition onto the conduit surfaces were studied analytically and experimentally. The model developed assumes validity of the heat-mass analogy under conditions of radioactive decay and an imperfect sink that may saturate and postulates a classical adsorption-desorption interaction at the conduit surface. Mass balances in the carrier stream and on the conduit surface result in a set of time-dependent, nondimensional differential equations. These equations express the concentration in the gas stream and on the conduit surface as functions of time, axial position, and the identified fission product deposition parameters. Equilibrium solutions are presented along with transient solutions of a limiting condition of the equations shown to be equivalent to a set in the literature. The experimental facility, built to observe out-of-pile deposition, basically contains an isothermal helium circulating loop, provisions for installing different test sections, and a system for injecting a variety of radioactive isotopes at rates simulating release from reactor fuel. Results for the deposition of iodine on low carbon and stainless steel are presented and compared with the theory. (auth)

1350 (TIM-950) INVESTIGATION OF BLAST WAVES FROM A SPHERICAL CHARGE USING THE Ax-TNT CODE. Anderson, C. J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). July 28, 1965. Contract AT(30-1)-2789. 14p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The usefulness of an Ax-TNT code for blast wave investigations is determined. To accomplish this, several cases were run with TNT loading ranging from 20 to 2000 pounds. A separate study was made of the effect of varying the energy density of TNT. For this study, cases were run with TNT energy densities ranging from 10 to 10,000 cal/gm and with a mass density of 1.6 gm/cm^3. Results from these tests are included. (M.O.W.)

1351 (WASH-1060) NUCLEAR REACTORS IN THE SOVIET UNION. Report of Reciprocal Exchange Trip to U.S.S.R. by U. S. Atomic Scientists, December 11-22, 1964. (Atomic Energy Commission, Washington, D. C.). 67p. Dep. mn; GPO $0.50 cy.

The descriptions and operating experiences of several reactors of the following types are given; fast breeder, nuclear superheat, boiling water, pressurized water, special purpose power reactors, and test reactors with auxiliary facilities. (M.O.W.)

1352 (JPRS-31526) THE 1963 ANNUAL REPORT OF THE NETHERLANDS REACTOR CENTER. Translation of Jaarveslag 1963—Reactor Centrum Nederland. (TT-65-32022). CFSTI $3.00 cy, $0.75 mn.

Startup of Krito reactor for Nero reactor fissionable material configuration measurements is reported. Operation of the high-flux (HFR) and low-flux (LFR) reactors during the period is summarized. Radiation effects testing of pressure vessel steels and uranium oxide tablets is reported along with developmental work on fuel elements and waste disposal. Research on health protection and biology is summarized, and an appraisal of research results is included. Information is included concerning collaboration with Norwegian atomic energy research groups, research on homogeneous suspension reactor project, and industrial collaboration. Administrative information is also included along with personnel and financial summaries. (J.R.D.)

1353 SAFETY PROBLEMS OF REACTORS. Gyimesi, Zoltan; Zobor, Ervin. Energia Atomtech., 18: 197-200(Apr. 1965). (In Hungarian).

International collaboration in the field of reactor safety is discussed. Papers presented at the 1962 symposium of IAEA and at several sections of the Third Geneva Conference are reviewed. Carefully applied controls enabled the United States to operate 1200 reactor-years without any injury to the population at large. The danger is due primarily to the large amount of radioactive materials accumulated in the fuel elements, from which they might escape to the surrounding countryside. However, it was found that fuel element damage occurs less often than boiler accidents; thanks to the leak detecting systems, their effects are minimized. Considerable work is in progress on the consequences of the maximum credible accident. Tests with the SPERT-1 system revealed that the environment is not much affected by a $2.7 reactivity accident. The worst reactivity accident, involving the SL-1 reactor, released only 10% of the fission products and contaminated only the reactor building proper. The MCA approach requires a pessimistic evaluation of each unfavorable factor, determining the consequences of a synthetic accident. Effects of the accident on the population may be minimized by zoning and by specially designed safety devices. Selection of the reactor site is of great importance. It is highly desirable to design an inherently safe system, based on negative temperature and void coefficients. Additional safeguards are built into the reactors to minimize the effect of accidents, should they occur; ventilating and filtering systems are especially important in this respect. (TTT)

1354 PROPOSED STANDARD NUCLEAR REACTOR CLASSIFICATION. Nucl. Eng. Bull., 3: 8-9(Aug. 1965).

The standard proposed classifies nuclear reactors into four primary categories and lists the classes within each category. The identifying characteristic, property, or product is listed for each class. The primary categories are: purpose, thermomechanical design, nuclear design, and development sequence. (M.C.G.)

1355 MODEL ANALYSIS OF ASEISMIC DESIGN OF A NUCLEAR REACTOR BUILDING. Toriumi, Isao (Fukui Univ., Japan). Nucl. Struct. Eng., 2: 301-5(1965).

An experimental study on the response of a nuclear reactor building under earthquake loading was done by model testing on a random shaking table and a field test by blasting in order to get some data for aseismic design. In the

case in which the basement is founded on firm rock, the lobar modes with natural frequency 3 ~ 4 c/s are predominant at the container shell and the outer concrete shield. (auth)

1356 PHYSICS. Power Reactor Technol., 8: No. 3, 157-62(Summer 1965).

Work directed toward interpretation of measured changes of control rod positions in the Sodium Reactor Experiment in forms of reactivity values is summarized. Results of performance tests in the Plutonium Recycle Test Reactor to investigate Pu-fueled D_2O-moderated reactors are outlined. Operation of the Experimental Breeder Reactor I with a Pu loading is summarized. Work on resonance absorption is discussed. Design calculation method for gas-cooled reactors coded in Fortran in the Argosy program is reported along with a method of obtaining reduced-delay-group parameters by least-squares fit. (J.R.D.)

Auxiliaries and Components

Refer also to abstract 465.

1357 (ORNL-P-1432) PARALLEL-PLATE MULTISECTION IONIZATION CHAMBERS FOR HIGH-PERFORMANCE REACTORS. Roux, Dominique (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 30p. (CONF-651105-1). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Conference on Nuclear Electronics, Bombay.

A new model of parallel plate multisection ionization chambers for reactor control was developed to meet the requirements of high performance research and power reactors. The chamber design, construction, and performance are discussed. (M.O.W.)

1358 PRESTRESSED CONCRETE PRESSURE-VESSELS. Concrete and Constr. Eng., 60: 189-94(May 1965).

Two of the nuclear power stations in the course of construction in Great Britain are to be provided with prestressed concrete pressure-vessels, namely, those at Oldbury, Gloucestershire, and Wylfa on the Isle of Anglesey. Certain aspects of the pressure-vessels are described in great detail. (auth)

1359 NEW INSTRUMENTS FOR THE MEASUREMENT OF THE NEUTRON FLUX DENSITY AND THE RADIATION SURVEY AT NUCLEAR REACTORS. Kalusche, H. (Siemens and Halske AG, Karlsruhe, Ger.). Kerntechnik, 7: 206(May 1965). (In German).

A brief introduction is given to discussion on new reactor instrumentation for neutron flux density measurement and radiation monitors. (L.B.S.)

1360 A TRANSISTORIZED REACTOR PULSE CHANNEL WITH HIGH RESOLUTION. Schmidl, J. (Siemens and Halske AG, Karlsruhe, Ger.). Kerntechnik, 7: 206-9(May 1965). (In German).

A description is given of a newly developed impulse channel equipped with transistors, consisting of BF_3 counter, preamplifier, amplifier with integral limit, logarithmic ratemeter and high-voltage unit. Special attention is given to the increase of resolution by using a BF_3 counter and the decrease of susceptibility to perturbation influence. (auth)

1361 TRANSISTORIZED D.C. CHANNELS FOR REACTOR INSTRUMENTATION. Sibler, W. (Siemens and Halske AG, Karlsruhe, Ger.). Kerntechnik, 7: 209-11 (May 1965). (In German).

Following the experiences made with d-c channels containing tube complements for reactor instrumentation, a transistorized instrumentation has been developed. This instrumentation includes, besides the usual d-c amplifier with logarithmic and linear measuring ranges, a d-c amplifier with a permanent measuring range for quick and precise measurements in the power range of the reactor. The sensible d-c amplifiers comprise an automatic, successfully proved drift compensation. The 18 measuring ranges of the linear amplifier can be remote-controlled. The circuit following the d-c channels is galvanically separated by buffers. (auth)

1362 A NEUTRON AND GAMMA RADIATION MONITOR FOR NUCLEAR REACTORS. Schmidl, J. (Siemens and Halske AG, Karlsruhe, Ger.). Kerntechnik, 7: 212-13(May 1965). (In German).

A description is given of the fundamental set-up of a radiation monitor developed for use at nuclear reactors and applicable to gamma-radiation and neutron survey. (auth)

1363 PROVISIONS TO ENSURE AN UNDISTURBED OPERATION OF NUCLEAR REACTOR INSTRUMENTATION. Wehrle, G. (Siemens and Halske AG, Karlsruhe, Ger.). Kerntechnik, 7: 213-15(May 1965). (In German).

The operational safety of nuclear reactor instrumentation depends essentially on the nature of interference voltages interspersed by foreign equipment components. The order of magnitude of the cross-talk transmission equivalent and the nature of screening measures making possible a trouble-free operation have been evaluated. (auth)

1364 A RAPID METHOD TO ESTIMATE THE ELASTIC STRESS CONCENTRATION OF A NOZZLE IN A SPHERICAL PRESSURE VESSEL. Lind, N. C. (Univ. of Waterloo, Ontario). Nucl. Struct. Eng., 2: 159-68(1965).

A simple method of determining the elastic stress-concentration factor of radial reinforced outlets from spherical vessels subjected to internal pressure is outlined. The computed values of the stress-concentration factor are compared with the results of photoelastic tests, showing good agreement, ordinarily within 10% or less. (auth)

1365 STRESS CONCENTRATIONS IN THE NOZZLE RING OF A PRESSURE VESSEL. Stepanek, Stanislav (Lenin Works, Pilsen, CSSR). Nucl. Struct. Eng., 2: 211-23(1965).

Some problems in the construction of cooling medium inlet and outlet nozzle rings of reactor pressure vessels are discussed. The factors affecting the stress concentration factor in this part of the vessel were identified theoretically and experimentally. It was determined that the stress concentration factor depends on the form of the hole in the vessel shell, on the number of holes made on the periphery of the vessel, on the curvature and wall thickness of the vessel shell, and on the reinforcement of the hole of the nozzle to the vessel. (auth)

1366 QUALITY CONTROL AND NONDESTRUCTIVE TESTING IN REACTOR PRESSURE VESSEL FABRICATION. McGonnagle, W. J. (IIT Research Inst., Chicago). Nucl. Struct. Eng., 2: 293-300(1965).

A quality control program for the design and fabrication of a nuclear reactor pressure vessel which will meet all nuclear and safety requirements is briefly outlined and it is shown how nondestructive testing can help to achieve the broad objective. Failure in materials, components, and assembly has demonstrated that present techniques of fabrication are not sufficient alone to assure repeated reliability in critical components. Flaws and inhomogeneities occur when using the best processes and properly controlled procedures. Thus an adequate and well integrated nondestructive testing program is necessary to assure the quality level required in a nuclear reactor pressure vessel. The principal nondestructive methods used in the fabrication of reactor pressure vessels are: visual, x-ray and gamma radiography, ultrasonics, magnetic particle, and liquid penetrant. The nondestructive testing program must include the inspection of plate material, forging, casting, cladding, and welds. Various methods and their application to the nondestructive testing of pressure vessels and components will be illustrated and discussed. (auth)

1367 COMPONENTS. Power Reactor Technol., 8: No. 3, 176-82(Summer 1965).

Improvements in resistance-type liquid metal level probes are reported. A continuing surveillance program in the Plutonium Recycle Test Reactor to determine the extent

of in-reactor fretting attack on Zircaloy-2 pressure tubes is reviewed, and methods of minimizing tube wear are discussed. (J.R.D.)

1368 SYSTEM FOR PROVIDING AN ELECTRICAL CONNECTION ALONG A NUCLEAR REACTION CHANNEL. Liermann, Jean (to Commissariat a l'Energie Atomique). British Patent 1,002,625. Aug. 25, 1965. Priority date Dec. 18, 1962, France.

A system for providing an electrical connection along a reactor channel for measuring, for instance, temperature at the level of a fuel cartridge is described. Particularly, the system is adapted for transmitting a potential difference from the level of the one fuel cartridge disposed among a number of cartridges in the channel. The cartridges are received and supported separately or in a group in outer tubular supports or sleeves juxtaposed end to end. Electrical connecting elements are fitted directly to the sleeves, and the element of each sleeve is electrically connectable with the elements of the two adjacent sleeves by axial contact between the sleeves. The connection elements are rigid conductive rods each received with slight clearance for longitudinal movement in each sleeve. Each rod is of substantially the same axial length as the sleeve receiving it and is slightly offset longitudinally relative to the sleeve so that one of the rod ends projects beyond one of the axial ends of the sleeve to form a male member of an electrical connection. The other rod end stops short of the other axial end of the sleeve to form a female member to cooperate with a male member of another sleeve. (B.L.M.)

1369 NUCLEAR REACTOR CONTROL ROD OPERATING DEVICE. Filloleau, Etienne; Haffemayer, Marcel; Maulard, Jean (to Commissariat a l'Energie Atomique). British Patent 1,003,020. Sept. 2, 1965. Priority date June 27, 1961, France.

A device for operating the control rods of a reactor, particularly a reactor cooled by circulation of a molten metal, includes a control differential gear having an output element and two input elements. The first input element is adapted to be rotated in both directions by a power unit, and the second input element is adapted to be rotated in the direction that moves the control rod toward its safety position by an actuating device comprising at least one spring to rotate the element. The first input element can be rotated at substantially different speeds in each direction. The output element is a ring gear that meshes with a rack carried by an operating bar supporting the control rod. The control rod may be a shim rod, a regulating rod, and/or a safety rod. (B.L.M.)

1370 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to American Machine and Foundry Company). British Patent 1,003,215. Sept. 2, 1965. Priority date Dec. 23, 1960, United States.

A method is provided for cooling a reactor of the swimming pool type that overcomes the disadvantage of high activity at the surface of the shielding liquid. A container is provided for the shielding liquid, and the reactor core is located in the container. The core includes one or more fuel elements, each of which comprises at least one fuel plate contained in a housing. The housing is effective to isolate the fuel plate from the shielding liquid. A closed coolant path is provided in which the coolant is circulated through each housing of each fuel element, the heat is removed from the coolant by heat exchange means, and the coolant is recirculated. (B.L.M.)

1371 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR PLANT. (to Sulzer Brothers Ltd.). British Patent 1,003,410. Sept. 2, 1965. Priority date May 17, 1963, Switzerland.

A method of controlling a nuclear reactor plant consists of circulating in at least one cooling circuit the coolant that gives up its heat in at least one heat exchanger to a load medium circulating in at least one load circuit. The temperature of the coolant at its exit from the reactor is maintained substantially constant, while the rate of flow of the load medium through the heat exchanger is controlled in dependence upon the temperature of the coolant leaving the heat exchanger. When the power output of the reactor changes, the rate of flow of the load medium through the heat exchanger is additionally adjusted by a signal dependent upon the changed reactor output. (B.L.M.)

1372 IMPROVEMENTS IN OR RELATING TO SHUTDOWN APPARATUS FOR NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 1,003,723. Sept. 8, 1965. Priority date Aug. 5, 1963, United States.

A control rod assembly for a nuclear reactor includes provision for release of a neutron absorber material into the reactor when the reactor temperature exceeds a preselected temperature. A filler of the neutron-absorbing material is disposed in a hollow housing in the control rod assembly. A portion of the housing is formed of a fusible material that melts when the reactor temperature exceeds the preselected maximum to allow the filler to be discharged into the housing. The filler material is in the form of discrete elements in the form of small bricks or round pellets. The housing is placed inside a vertical guide tube in the reactor core, and the guide tube is closed at the bottom so that the filler discharged from the housing is caught at the bottom in the guide tube. The filler is readily removed by removing the guide tube. (B.L.M.)

1373 IMPROVEMENTS IN OR RELATING TO THE CONTROL OF NUCLEAR REACTORS. Taylor, Anthony James; Peters, Martin Charles (to Babcock and Wilcox Ltd.). British Patent 1,005,177. Sept. 22, 1965. Filed Dec. 22, 1961.

Reactivity control means for a reactor includes conduit means extending from outside the core through a range of levels within the core arranged to convey a fluid medium containing body or bodies providing neutron absorbent material. The conduit means is arranged to convey the fluid at a varying velocity and to move the neutron absorbent material along the conduit against a biasing force under the influence of fluid flow. Means are provided for varying the fluid flow, and the arrangement is such that the level or range of levels within the core at which the neutron absorbent material is positioned is variable by alteration of the flow rate. Provision is made for positioning all the neutron absorbent material within the core in the shortest possible time in the event of a "scram" or emergency shut down. (B.L.M.)

1374 MECHANICAL COUPLING DEVICE, ESPECIALLY FOR PRESSURE VESSELS. Leclou, Andre (to Commissariat a l'Energie Atomique). British Patent 1,005,285. Sept. 22, 1965. Priority date July 24, 1962, France.

A coupling device is provided for the mechanical connection of two parts of a vessel, e.g., a pressure vessel, which has an axis of symmetry and which is subjected to stresses directly parallel to the axis tending to separate the two parts. The two parts of the vessel are provided with two elements, such as two annular plates, secured to the parts of the vessel at an angle other than the axis of symmetry. At least one of the elements is secured to the corresponding part of the vessel by a mechanical force transfer means. Alternatively, the parts of the vessel may be a tank barrel and a flat base supported on a foundation block to which are secured anchor bolts parallel to the axis of the vessel. The anchor-bolts are coupled to the element that is rigidly fixed to the tank body, and the tank body and the base is welded together to insure fluid tightness. (B.L.M.)

1375 PROCESS FOR BALANCING THE OUTPUTS IN A MATRIX SYSTEM FOR SAMPLING THE FLUID OF A DEVICE FOR DETECTING FAULTS IN CASINGS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,246,247. Oct. 10, 1960. Filed Oct. 3, 1959.

The balancing process consists essentially in providing each channel of a matrix system for sampling by row or column and each of the row or column collectors with a variable number of material means for introducing into

the flow of fluid an elementary loss of pressure of predetermined and preferably uniform value. Said means should be such that the outputs are equal in all the channels for sampling by row or column respectively, on the one hand, and in all the row or column collectors, on the other hand. (IIB)

1376 SUPPORT STRUCTURES FOR VERTICALLY-STACKED SOLID MODERATOR BLOCKS OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,294,305. Apr. 16, 1962. Filed Apr. 14, 1961.

Vertically-stacked solid moderator blocks are supported by a rigid central support member and by a series of rigid, independent, concentric and co-adjacently arranged supporting rings. The support member and each supporting ring may rest on struts bearing on the base of the reactor housing and symmetrically arranged around the axis of the stack in planes passing through said axis. The central support member and supporting rings are connected to one another by pins engaging in radial slots provided therein so as to enable adjacent rings to move or deform slightly to each other. Each supporting strut comprises a joint at its end connected to the support member or to a ring, the axis of the joint being perpendicular to the plane containing the axis of the stack and that of the strut in such a way as to ensure the lateral rigidity of the supporting member and ring assembly. (IIB)

1377 IMPROVEMENTS IN NUCLEAR REACTORS, AND MORE PARTICULARLY TO A METHOD FOR THE DISTRIBUTION OF THE MODERATOR. (to Societe Anglo-Belge Vulcain). French Patent 1,329,607. May 6, 1963. Priority date Mar. 9, 1961, Belgium.

In certain nuclear reactors, fluids at variable temperatures are adapted to flow inside chambers, which are surrounded on their outside by other fluids at temperatures that are different from those of the first mentioned fluids. The temperature variations of the latter fluids may be frequent and important. In the metallic pieces bathed by such fluids, contraction movements are produced followed by expansion movements, which create extremely dangerous alternating stresses. To withstand these stresses a sufficient flexibility is imparted to the metallic pieces so that they may lead the fluids at variable temperatures to the places of their utilization while avoiding dangerous stresses. (IIB)

1378 SPECIMEN SUPPORT FOR USE IN A NUCLEAR REACTOR. (European Atomic Energy Community (EURATOM)). French Patent 1,334,563. July 1, 1963. Priority date July 20, 1961, Belgium.

The invention provides a specimen support which can be assembled as a unit with a fuel element and the unit loaded and unloaded from the experimental channel. The support comprises a specimen tube for insertion into the channel. Within the tube are means for locating a specimen therein and means for guiding a cooling fluid in a circulatory path. (IIB)

1379 METHOD OF DETECTING LEAKS IN FUEL ELEMENTS OF A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,334,833. July 1, 1963. Priority date Oct. 17, 1961, Great Britain.

A method is described to detect leaking fuel elements in an operating nuclear reactor having a gaseous carbon dioxide coolant under pressure and fuel elements, located in channels through which the coolant flows. Each fuel member is enclosed in a protective sheath also containing a gas inert to the fuel members and reactor components. The method comprises the steps of sampling the coolant gas before it enters the channels and on leaving the channels, amplifying the inert gas concentration in the samples with respect to the coolant. By means of a mass spectrometer, the inert gas concentration, in samples taken before the coolant enters the channels, is compared with samples, taken as the coolant leaves the channels. An increase in inert gas concentration indicates a leaking fuel element. (IIB)

1380 IMPROVEMENT IN NUCLEAR REACTOR CORES. (to The Nuclear Power Plant Co., Ltd.; A.I.E.-John Thompson Nuclear Energy Co., Ltd.). French Patent 1,342,721. Sept. 30, 1963. Priority date Jan. 23, 1962, Great Britain.

Due to the effect of irradiation or other causes, the bricks of a nuclear reactor core may become tilted relative to one another, and as a result the cooling fluid may leak between adjacent blocks. To meet these inconveniences sealing means are provided between adjacent blocks to prevent or reduce such leakages. The sealing means comprise at least one sealing ring located in a recess formed between opposed end faces of adjacent blocks. The opposed faces of adjacent blocks may have stepped ends which coact with one another to form a leakage path of stepped form. The opposed faces have two portions lying in separate planes at right angles to the axis of the bores for passage of cooling fluid, and a metal sealing ring is located between said faces. (IIB)

1381 PRESSURE VESSELS. (to United States Atomic Energy Commission). French Patent 1,345,789. Nov. 4, 1963. Priority date Nov. 16, 1961, United States.

An internally insulated and externally cooled pressure vessel for a gas-cooled nuclear reactor is designed and fabricated in such a way that the thermodynamic efficiency of a closed-cycle system including the reactor is enhanced. The internal insulation of the vessel precludes rapid temperature changes in the inside surface of the vessel with respect to the outer surface, thereby eliminating thermal stress and resulting cumulative fatigue damage. The internal insulation has also a shape which will minimize contamination of the coolant by radiation particles held up in the system and can efficiently withstand rapid reactor depressurization. (IIB)

1382 PNEUMATIC TRANSPORT TUBE CONTAINER FOR USE IN A NUCLEAR REACTOR. (to European Atomic Energy Community (EURATOM)). French Patent 1,362,884. Apr. 27, 1964. Priority date Sept. 13, 1962, Germany.

When rabbits are used in nuclear reactors to expose samples of materials to the radiation and neutron field of the reactor, a problem occurs when it is required to measure activities of a sample which are so short-lived that the time required to transport the sample to the measuring station and to take the sample out of its container are of importance. In accordance with the invention a weighted element is freely mounted in a container behind the sample material to be conveyed. This element is adapted to open a closure and at the same time to expel the material, when the container strikes against an abutment member at the point of arrival. The inert mass of the weighted element acts instantaneously with all its kinetic energy in the direction of movement on the closure and on the material. (IIB)

1383 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (The Nuclear Power Plant Co., Ltd.; A.E.I.-John Thompson Nuclear Energy Co., Ltd.). French Patent 1,366,384. June 1, 1964. Priority date Sept. 10, 1962, Great Britain.

A nuclear reactor has a graphite core enclosed by a concrete pressure vessel. The core is assembled by graphite bricks arranged in spaced vertical columns supported on a base supporting structure. This structure comprises a plurality of separate spaced pedestals, each pedestal supporting a column of bricks being locked thereto. Vertical members are disposed around the periphery of the core in order to give lateral support to the core. The ends of the vertical members are located in concrete in such a way that one end is free to expand. (IIB)

1384 OSCILLATING ASSEMBLY FOR AN IRRADIATED FUEL ROD IN AN EXPERIMENTAL LIQUID MODERATED NUCLEAR REACTOR. (to European Atomic

Energy Community (EURATOM)). French Patent 1,371,463. July 27, 1964. Priority date Oct. 5, 1962, Belgium.

To measure the effective absorption cross section of an irradiated fuel rod, two coaxial fuel rods, one irradiated and the other non-irradiated, are used. The two rods are connected together for movement as a unit, and an arrangement is provided by which the two rods may be moved axially between two positions: (a) a position in which the non-irradiated rod is in the core of the reactor and the irradiated rod is outside the core, but within the screening; (b) a position in which the irradiated rod is in the core and the non-irradiated rod is outside the core and outside the screening. (IIB)

1385 MATERIALS TESTING APPARATUS. (to United Kingdom Atomic Energy Authority). French Patent 1,374,606. Aug. 31, 1964. Priority date Oct. 22, 1962, Great Britain.

The invention is primarily concerned with apparatus for submitting stressed steel specimens to irradiation in a nuclear reactor. The apparatus comprises a load member, a support member and pivotable linkage means interconnecting the load and support members. The specimen is interconnected between the support member and the linkage means so that the specimen is stressed when opposing forces are exerted on the load and support members. (IIB)

1386 IMPROVEMENTS IN NUCLEAR REACTORS. (to United States Atomic Energy Commission). French Patent 1,376,249. Sept. 14, 1964. Priority date Dec. 26, 1962, United States.

The invention relates to means for increasing the thermal neutron flux available for experimental purposes in the reflector of a heterogenous, water-cooled and -moderated, beryllium-reflected nuclear reactor. In order to produce a local peak of thermal neutron flux a small amount of beryllium is substituted by light water adjacent to the end of each beam tube in which an increased neutron flux is desired. Proper coordination of the relative thickness of the beryllium and the water layers provides a substantial increase in the thermal flux available in the horizontal beam tubes at the expense of only a minor loss in reactivity. (IIB)

1387 STAND PIPES FOR NUCLEAR REACTORS. (to United Kindom Atomic Energy Authority). French Patent 1,378,516. Oct. 5, 1964. Priority date Dec. 21, 1962, Great Britain.

A number of stand pipes extend through a prestressed concrete pressure vessel surrounding a gas cooled nuclear reactor in order to assure the communication with a fuel channel. Through the region of the pressure vessel containing prestressing wires, a plurality of coolant-carrying pipes are symmetrically disposed around the standpipe so that their axes are parallel to the axis of the standpipe. (IIB)

1388 APPARATUS FOR DRIVE OF AN EXISTING AGENT INSIDE AN ELASTICALLY DEFORMED SEALING TUBE, WHICH IS COMBINED WITH THE CONTROL AND SHUTDOWN RODS OF A NUCLEAR REACTOR. Dupuy, Gerard (to Commissariat a l'Energie Atomique). German Patent 1,192,336. May 6, 1965. Priority date July 18, 1960, France.

The driving mechanism comprises a sliding carriage provided with two opposing, shallow recesses and sliding axially in a sealing tube with flexible walls. The control rod is attached to this sliding carriage. Outside the tube is an axially moved drive device comprising two radially swingable levers which are pressed against the flexible wall of the tube in such a way that by deforming the wall the roller body at the end of each lever is force-locking connected to the sliding carriage inside the tube. (Gmelin Inst.)

1389 PLANE SUPPORTING SURFACE FOR A SOLID, VERTICALLY ARRANGED MODERATOR STRUCTURE OF A NUCLEAR REACTOR. Rouge, Pierre (to Commissariat a l'Energie Atomique). German Patent 1,194,071. June 3, 1965. Priority date Apr. 14, 1961, France.

The supporting surface consists of a plurality of independently supported individual rigid planes which are arranged concentrically to a central supporting surface and have an annular shape. The single planes are supported in such a way that they may move independently in radial directions. (Gmelin Inst.)

1390 SOLID CONSTRUCTION OF A MODERATOR FOR NUCLEAR REACTORS. Lemesle, Georges; Manes, Roger; Rouge, Pierre (to Commissariat a l'Energie Atomique). German Patent 1,194,072. June 3, 1965. Priority date Nov. 20, 1961, France.

The stack is formed of identical prismatic rods, the lateral faces of which are provided successively with a rib then a groove by means of which the coupling of the lateral faces with adjacent rods is effected as a result of the engagement of the ribs in the corresponding grooves. The ribs and grooves are defined in such a way that the distance between the longitudinal axis of the rod and the bottom of each groove is equal to the distance between the longitudinal axis and the base of each rib. (Gmelin Inst.)

1391 LOADING MACHINE FOR NUCLEAR REACTORS CHANNELS. Lemesle, Georges; Monteil, Marcel; Rouge, Pierre; Roche, Roland (to Commissariat a l'Energie Atomique). German Patent 1,195,876. July 1, 1965. Priority date Feb. 20, 1962, France.

A charging machine within the shielding of a nuclear reactor comprises a framing mounted on rails which is moved above the fuel element channels, a handling structure rotatable in relation to the framing which has a storage magazine for the fuel elements, and a radially movable gripping device in the handling structure. The rotational and radially directed movements are coupled. (Gmelin Inst.)

1392 EQUIPMENT FOR THE INSTALLATION AND DISASSEMBLY OF AN APPARATUS IN OR OUT OF A NUCLEAR REACTOR. Hoffmeister, Bernard (to Beteiligungs- und Patentverwertungsgesellschaft mit beschraenkter Haftung). German Patent 1,196,305. July 8, 1965. Filed July 19, 1962.

The apparatus comprises a shielded container and a multi-step spindle drive located in the container which is operated from outside and to the last step of which there is attached a gripping device. The spindle drive of this apparatus is further improved. (Gmelin Inst.)

1393 SHOCK-ABSORBING DEVICE FOR NUCLEAR REACTOR CONTROL RODS. Gerard, Victor Jean; Martin, Jean Antoine (to Groupement Atomique Alsacienne Atlantique (G.A.A.A.). German Patent 1,199,896. Sept. 2, 1965. Priority date May 5, 1961, France.

The control rod falls until the conical face of its lower end hits a complementary face formed around the upper edge of a tubular member located at the lower end of the control rod channel. The control rod is thus arrested by the tubular member and the kinetic energy of the falling control rod is absorbed by the distortion of the tubular member. (Gmelin Inst.)

1394 APPARATUS FOR MONITORING THE STRUCTURAL INTEGRITY OF A CONTROL ROD FOR A NUCLEAR REACTOR. Paget, John Arthur (to General Dynamics Corp.). German Patent 1,198,944. Aug. 19, 1965. Priority date July 31, 1961, United States.

The apparatus comprises an electrical conductor extending along the control rod; means are provided for securing the conductor to the control rod at least at two locations along its length, along with means connected to the electrical conductor for yielding an indication of a severance of the conductor which accompanies a break in the control rod between the locations. (Gmelin Inst.)

1395 APPARATUS FOR THE AUTOMATIC CONTROL OF NUCLEAR REACTORS. Steinert, Christoph (to Deutsche Babcock and Wilcox-Dampfkessel-Werke). German Patent 1,200,451. Sept. 9, 1965. Filed Apr. 7, 1960.

The control element has a closed tube extending into the

reactor core and containing material of high microscopic thermal neutron absorption cross section the vapor density of which varies in accordance with the temperature within the core to control the reactivity of the core. The closed tube is arranged to be affected by the outlet temperature of the coolant passing through the core. By a choice of suitable material the absorbing material will remain substantially in the solid or liquid state in the lower end of the tube at normal operating temperatures. (Gmelin Inst.)

1396 DEVICE FOR THE DETECTION OF DEFECTIVE FUEL ELEMENTS IN NUCLEAR REACTORS. **Kraemer, Juergen; Schimmel, Wolfgang (to VEB Atomkraftwerk Rheinsberg). German Patent 1,200,452. Sept. 9, 1965. Filed Nov. 26, 1960.**

The device for the detection of faulty fuel elements in heterogeneous nuclear reactors comprises removable solid adsorbent bodies disposed at the exit of each of the coolant tubes which contain the fuel elements. The adsorbent bodies are removed from the core and are examined by radiation instruments. The adsorbent bodies are constructed in the shape of Venetian blinds, the geometry of which is automatically altered in response to one or more operation values of the reactor. (Gmelin Inst.)

1397 PROCESS AND MEANS FOR REMOVING RADIOACTIVE COMPONENTS FROM GASES AND GASEOUS MIXTURES. **Lehmer, Wilhelm; Baldus, Wolfgang; Stich, Walter (to Linde's Eismaschinen AG). U. S. Patent 3,203,866. Aug. 31, 1965. Priority date Dec. 2, 1958, Germany.**

A process is reported for the purification of gases that have been contaminated with radioactive substances while being used as cooling or protecting gases for spaces contaminated with radioactive substances. The purification plant includes at least one sorption device through which the gas is passed to free it of the contaminants. A buffer of protective gas is formed about at least a part of the plant by leading the gas freed from radioactive substances through a special jacket or encasement around all connections or points at which leaks might occur which contain the radioactive gas. After passing through the special encasement, the purified gas is then returned to the contaminated space, such as a reactor cooling system, for further use as cooling or protecting gas. (B.L.M.)

1398 SIMULATED FUEL ASSEMBLY. **Savino, Joseph M.; Lanzo, Chester D. (to National Aeronautics and Space Administration). U. S. Patent 3,205,141. Sept. 7, 1965. Filed May 31, 1963.**

A flow-measuring instrument that is extremely accurate and has a short response time to changes in flow is particularly applicable for measuring coolant flow in a reactor. The device includes a simulated fuel assembly that is located at a predetermined position in the reactor with means for circulating coolant through the assembly and includes means for duplicating the pressure loss versus flow rate characteristics of a fuel assembly. A turbine flow meter is contained in a housing having an inlet for admitting and an outlet for discharging the coolant. A flow resistor is mounted in the housing in the flow path of the coolant. (B.L.M.)

1399 HANDLING APPARATUS FOR GAS-COOLED NUCLEAR REACTOR INSTALLATION. **Lemesle, Georges; Martin, Roger; Vivien, Jean (to Commissariat a l'Energie Atomique). U. S. Patent 3,205,143. Sept. 7, 1965. Priority date Oct. 6, 1962, France.**

A handling apparatus for a gas-cooled heterogeneous reactor comprises a garret chamber arranged in the biological protection shield of the reactor and separated from the chamber occupied by the core of the reactor by a wall having orifices in it and giving access to the channels in the core accommodating the fuel elements. The reloading installation includes an additional apparatus for introducing into the garret containers provided with new elements and removing used elements from the garret. This handling apparatus comprises a beam mounted in the garret to be rotatable about an axis parallel to the channels, driving means for rotatably driving the beam, and an assembly movable along the beam and carrying a movable gripping device parallel to the axis of rotation of the beam. First and second driving means are arranged outside the shield in a chamber connected to the garret and are connected to the movable assembly and the gripping device respectively by flexible means extending through the shield. (B.L.M.)

1400 PROCESS AND DEVICES OF HEAT EXCHANGE AND NUCLEAR REACTOR EMBODYING SAME. **Foure, Claude Desire; Mihail, Arlette Marcelle (to Societe Nationale d'Etudes et de Construction de Moteurs d'Aviation). U. S. Patent 3,205,147. Sept. 7, 1965. Priority date Mar. 21, 1959, France.**

A process and device are described for improving the coefficient of thermal exchange between a wall and a fluid by organizing the turbulent system in a stable and coherent manner. The heat exchange takes place in a space or chamber where the fluid flows are constituted by a number of joined elementary chambers, each extending over the whole length of the exchange chamber. The rotation of fluid in each elementary chamber is obtained by means of apertures provided in the walls and/or by means of deflector members. The apertures allow entry of jets of fluid tangentially with respect to each elementary chamber. If the deflector members are used, they are disposed within the fluid flowing in each elementary chamber, and a motive difference of pressure is established between the opposed extremities of the different elementary chambers. (B.L.M.)

1401 METHOD OF REPLACING FUEL ELEMENTS IN A NUCLEAR REACTOR. **Bosshard, Ernst (to Sulzer Freres). U. S. Patent 3,206,366. Sept. 14, 1965. Priority date Mar. 4, 1960, Switzerland.**

A method is described for changing fuel elements in a reactor that is applicable to oblong fuel elements inserted in a container having provision for coolant flow through the container. The container is never removed from the biological shield, so the number of cans necessary is reduced and only the relatively light spend element or new element need be moved through the radiation shield. The spent fuel element is removed from and the new element inserted into the can through the opening where the coolant is supplied. (B.L.M.)

1402 MACHINES FOR LOADING AND UNLOADING THE CHANNELS OF A NUCLEAR REACTOR. **Peuchmaur, Alphonse; Gillieron, Claude; Canet, Pierre (to Commissariat a l'Energie Atomique). U. S. Patent 3,206,367. Sept. 14, 1965. Priority date Aug. 16, 1961, France.**

A slug loading and unloading machine is described for use with a reactor where the channels have a central portion of uniform diameter in the reactor core and at least one end portion of larger diameter opening into a free face of the reactor. The frame of the loading machine moves parallel to the face of the reactor and is provided with longitudinal passage parallel to the direction of the reactor channels. A tube is provided that is slidable longitudinally in the passage to communicate the machine with the reactor channel. Hooking or catching means provided at the end of the tube are adapted to project from the longitudinal passage for engaging the larger diameter elements such as protection slugs and plug. An inner rod slidable telescopically in the tube has a maximum external diameter that is slightly smaller than the central portion of the channel. In a projected position, the rod may engage the smaller diameter elements, such as fuel slugs, false slugs, and protection slugs by means of second hooking or catching means. Magazine storage is provided for the temporary storing of the elements, both large and small diameter, and communicates with a region of the passage where the outer tube and the inner rod are movable. (B.L.M.)

1403 COOLING CIRCUIT FOR A LIQUID-MODERATOR NUCLEAR REACTOR. **Costes, Didier (to Commissariat a l'Energie Atomique). U. S. Patent 3,206,368. Sept. 14, 1965. Priority date May 23, 1961, France.**

A cooling circuit is provided for a liquid-moderator

reactor of the type comprising an independent heat-carrying fluid circuit that ensures removal of the greater portion of the heat produced by fission by the passage of a fluid through the pressure tubes containing the fissile material and arranged in the moderator. The cooling circuit includes a condenser and at least two channels for the flow of fluid. At least one channel connects the upper part of the moderator tank to the condenser in order to admit vapor produced by the boiling of the moderator liquid to the condenser. The second channel connects the condenser to the moderator tank to send the condensate from the condenser back into the tank by gravity. (B.L.M.)

1404 SUPPORT STRUCTURE FOR VERTICAL STACK OF SOLID MODERATOR. Dupuy, Gerard (to Commissariat a l'Energie Atomique). U. S. Patent 3,206,373. Sept. 14, 1965. Priority date May 25, 1962, France.

A support structure for the moderator of a gas cooled reactor ensures that the lattice pitch on which the moderator columns are disposed is kept constant irrespective of the deformation of the support structure. The support structure for the columns of the moderator stack consists of an assembly of adjacent tiles separated by a lateral clearance and disposed side by side in the same horizontal plane. Each tile has a polygonal configuration admitting of a vertical axis of symmetry and is adapted to support an assembly unit formed by a limited number of columns. Each tile is coupled only to a central column that forms part of the assembly unit carried on each tile. Stationary fixed bearing surfaces for the tiles are provided by pillars, which are spaced symmetrically about the axis; and the lower portions of the pillars are thermally insulated from the tile. (B.L.M.)

1405 BELT RESTRAINT SYSTEM FOR MODERATOR-REFLECTOR STRUCTURE OF A NUCLEAR REACTOR. Lemesle, Georges; Roche, Roland; Rouge, Pierre (to Commissariat a l'Energie Atomique). U. S. Patent 3,206,374. Sept. 14, 1965. Priority date Nov. 8, 1957, France.

Support for a reactor body made up of reflector and moderator elements piled one upon another to form vertical body sections is provided by an open-meshed cylindrical cage type arrangement surrounding the reactor body. The cage is formed of a number of horizontal belts at different levels and bracing members fixed to the belts. Resilient means extend inwardly from the cage and bear against some of the reflector elements. The cage is supported exclusively at the base and absorbs outward forces without imposing stresses upon the casing that surrounds the structure. (B.L.M.)

1406 SYSTEM FOR FUEL ELEMENTS FAILURE DETECTION IN NUCLEAR REACTOR. West, John M. (to Combustion Engineering, Inc.). U. S. Patent 3,207,668. Sept. 21, 1965. Filed May 2, 1960.

A method is described for detection of a ruptured cladding on a fuel element in a reactor core in which numerous fuel elements are retained in spaced relation. The power output is sequentially increased in a programmed manner and in particular confined locations that collectively cover the entire core area. During this power increase, the gases that are collected from the reactor are continuously monitored with regard to their level of activity. If a rupture occurs, the increase in power raises the temperature; the temperature rise, due to gas expansion, will cause radioactive gases to be forced out the rupture in the fuel elements; and the monitor will indicate an increase in the activity level. (B.L.M.)

1407 CONTROL SYSTEMS FOR NUCLEAR REACTORS. Fawcett, Sydney; Barnes, Hale; Campbell, Ronald Hugh (to United Kingdom Atomic Energy Authority). U. S. Patent 3,207,669. Sept. 21, 1965. Priority date July 6, 1960, Great Britain.

A reactor control system consists of an operational control system for effecting stable control of the reactor with normal variations in performance and two shutdown systems. The first shutdown system (the restrained system) is separate from the operational control system. When abnormal variations in reactor performance are detected, the first shutdown system is moved irreversibly at a restrained rate in a direction to reduce reactivity of the reactor. On elimination of the abnormal conditions, the movement of the first shut-down system is arrested. The second shut-down system (the primary emergency system) operates at a faster rate than the first shutdown system and is released on the detection of conditions more severe than abnormal conditions. (B.L.M.)

1408 METHOD OF CONTROLLING A NUCLEAR REACTOR. Fletcher, John F.; Toyoda, Kadzuhisa, G. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,975. Oct. 19, 1965.

A method of controlling the temperature within a nuclear reactor is described in which the coolant traverses the reactor core in a plurality of passes, comprising monitoring the outlet temperature of the coolant from each pass, bypassing a portion of the coolant flow from the reactor inlet line to the inlet of each coolant pass, and adjusting the flow through the bypass lines inversely with respect to variations in the outlet temperature of the last pass bypassed while maintaining total flow of coolant through the reactor constant. (AEC)

1409 CONTINUOUS SUPPORT FUEL ROD SPACER SYSTEM. Brynsvold, Glen V.; Sangster, W. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,991. Oct. 19, 1965.

Spacers are described for holding fuel elements in a nuclear reactor core in fixed relation to each other. The spacer comprises an elongated tube having a plurality of slots arranged in offset parallel overlapping relation parallel to the longitudinal axis of the tube to provide a compliant positioning effect. The spacer tubes are placed in longitudinal contact in the interstitial spaces between fuel elements in the core of a nuclear reactor. (AEC)

Criticality Studies

Refer also to abstracts 1133 and 1534.

1410 (AHSB(S)HANDBOOK-1(1st. Rev.)) HANDBOOK OF CRITICALITY DATA. VOLUME I. Chalmers, J. H.; Walker, G.; Pugh, J. (comps.). (Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, Risley (England)). 1965. 142p. Dep.; BIS $8.40; HMSO £2. 2s.

Data are given for the following systems; uranium metal-water, uranium metal-nitric acid-water, uranium metal-graphite, uranium oxide-water homogeneous, uranium oxide, plutonium metal-water, plutonium metal-nitric acid-water, plutonium oxide-water, plutonium oxalate-water, plutonium nitrates, plutonium oxide-uranium oxide-water, and other miscellaneous enriched uranium dioxide-water systems. (M.O.W.)

1411 (CONF-650413-13) ON THE KINETIC THEORY OF SPATIAL AND SPECTRAL COUPLING OF THE REACTOR NEUTRON FIELD. Cockrell, Robert G.; Perez, R. B. (Florida Univ., Gainesville. Dept. of Nuclear Engineering). [1965]. Contract AT(40-1)-2097. 33p. Dep. mn; CFSTI $2.00 cy, $0.50 mn; Gmelin, AED-CONF-65-042-21.

From Symposium on Neutron Dynamics and Control, Tucson, Ariz.

From the time, space, energy, and angular dependent integro-differential form of the Boltzmann neutron transport equation, a set of coupled, ordinary first-order differential equations is derived which describe the kinetics of the spatial and spectral coupling of the reactor neutron field. The derivation is very general and is not restricted to any particular reactor configuration or type. The coefficients in the derived expression are defined in terms of diffusion theory as well as transport theory. Existing computer codes for performing the necessary computations are discussed. The results of calculations made on the UFTR, an Argonaut-type reactor, are presented. (auth)

1412 (IDO-17109) AN ANALYSIS OF THE EXCURSION BEHAVIOR OF A HIGHLY ENRICHED PLATE-TYPE D_2O-MODERATED CORE IN SPERT II. Johnson, R. L.; Larson, H. A.; McClure, J. A.; Norberg, J. A. (Phillips Petroleum Co. Idaho Falls, Idaho. Atomic Energy Div.). Sept. 1965. Contract AT(10-1)-205. 132p. Dep. mn; CFSTI $4.00 cy, $1.00 mn.

Presented is an analysis of experimental data obtained from self-limiting power excursions performed in the Spert II Reactor Facility with a highly enriched, U–Al, plate-type, D_2O-moderated, -reflected, and -cooled core in which 3-inch-square fuel assemblies were spaced on 3-inch centers to form a close-packed array. The tests were initiated from low power by stepwise insertions of reactivity with various combinations of initial system conditions: temperature (70 to 195°F), pressure (0 to 360 psig), and coolant flow rate (0 to 14 fps through the core). The reactivity insertions ranged from about 50¢ to 1.84$ and resulted in initial reactor periods ranging from about 5 sec to 74 msec. A reactivity feedback model which predicts transient response under forced coolant flow conditions and which is applicable to similar experimental reactor systems is developed and evaluated; calculated and experimental behavior are in good agreement. Temperature distribution calculations of the reactivity compensated by fuel plate and moderator expansion are within 20% of the results obtained by analysis of the power burst shape; possible reasons for the difference observed for this and other cores are postulated. Correlative analysis of the close-packed-core data indicates that less excess reactivity can be compensated without core damage under forced coolant flow conditions than with no flow. Comparison of close-packed core data with previously obtained expanded core results shows that the gross kinetic behavior is relatively insensitive to fuel orientation and that the effects of prompt neutron lifetime, system temperature, and system pressure are similar to those previously observed in the expanded core and in other Spert plate cores. (auth)

1413 (RT/ING(65)4) IL REATTORE PER ESPERIMENTI CRITICI CON MODERATORI ORGANICI—R.O.S.P.O. (REATTORE ORGANICO SPERIMENTALE POTENZA O). (Reactor for Organic Moderated Critical Experiments—R.O.S.P.O. (Reattore Organico Sperimentale Potenza O)). Gambardella, G.; Nicosia, S.; Pulacci, A.; Saya, P.; Zona, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Apr. 1965. 79p. Dep. mn.

The R.O.S.P.O. is a critical facility, built for the PRO project to test the physical features of organic moderated cores. The main design specifications are briefly outlined and a general description of the plant is given. (auth)

1414 EXPERIMENTAL DATA INTERPRETATION IN THRESHOLD NEUTRON SPECTROMETRY. Daddi, L.; D'Angelo, V. (CAMEN, Pisa, Italy). Energia Nucl. (Milan), 12: 515-23(Oct. 1965).

A method for threshold detector data treatment in reactor neutron spectrometry is described. The energy range is divided into two bands and the spectrum is approximated by mathematical functions with one or two parameters. Four test spectra were used in order to verify the method independently from the experimental errors. The effects of these errors were studied. (auth)

1415 INVARIANT IMBEDDING AND THE INTEGRATION TECHNIQUES OF REACTOR THEORY. Kaplan, S.; Gelbard, E. M. (Bettis Atomic Power Lab., West Mifflin, Pa.). J. Math. Anal. Appl., 11: 538-47(July 1965). (WAPD-T-1724).

The similarity between some special integration techniques of reactor theory and those derived from an invariant-imbedding approach is demonstrated. The invariant-imbedding formulation of a linear transport problem in the case of a continuous independent variable is outlined first. Several integration procedures suggested by this formulation are noted and are identified with procedures currently used in reactor programs. As a specific example of the finite difference case, the diffusion equations are treated from the conventional and the invariant-imbedding viewpoints. The propagation of roundoff in solving transport problems by an imbedding approach and by a more direct method is briefly considered. (D.C.W.)

1416 SPERT-I DESTRUCTIVE TEST WITH UO_2 FUEL. Ergen, W. K. Nucl. Safety, 5: No. 3, 231-4(Spring 1964).

Test procedure details are given and test results are analyzed. (J.R.D.)

1417 DERIVATION OF THE DESCRIBING FUNCTION FOR THE REACTOR OF POWER LEVEL. Smelts, Henri B. (European Nuclear Energy Agency, Paris). Nukleonik, 7: 399-405(Aug. 1965).

The describing function technique makes it possible to calculate the quasi-linear oscillations of a non-linear system, and to compare these oscillations with those of the linearized approximation of the system. The describing function of a nuclear reactor with linear power reactivity feedback is derived and general conditions for the existence of autonomous quasi-linear oscillations are defined. The present results constitute the first accurate and self-consistent derivation of the described function by the indirect method, the use of the harmonic balance of the reactivity. This method yields information on the role of various physical factors such as delayed neutrons, value of the inserted reactivity for going to power, first harmonic of the power, and reactor oscillations. Describing functions at constant average power and at constant average reactivity are obtained. The results, which are first-order corrections of the linear analysis, enable the difference between linear and quasi-linear oscillations to be calculated when this difference is small. The indirect method can also be used for the study of autonomous oscillations and shows that the reactors operating above the maximum power of stability may oscillate without external excitation. (J.S.R.)

1418 SOME CONSIDERATION ON NUCLEAR REACTOR NOISE. Dalfes, Abdi (Technical Univ., Istanbul). Nukleonik, 7: 426-7(Aug. 1965).

The output pulses of two neutron detectors which are placed in a zero power subcritical point reactor are considered, and some results on their cross correlation, cross spectrum, and joint probability distribution are presented. A detailed mathematical analysis of the Markovian process is not given. The results show that if the counting time is such that $(1-\rho^*)\beta T/l < 1$ then the method for determining the last break frequency of the cross spectrum makes it possible to compute $(1-\rho^*)\beta/l$ and hence the reactivity ρ^*. The non-neutronic noise does not affect the measurement. If the accounting time is again chosen as above, then the variation of the cross correlation function for short time delay makes it possible to compute $(1-\rho^*)\beta/l$ as in the Rossi-α method. The probability method for noise analysis enables the determination of the intrinsic state of the stationary subcritical reactor. (J.S.R.)

1419 SOME COMMENTS ON THE ROSSI-α EXPERIMENT. Bryce, Donald H. (Kaman Nuclear, Colorado Springs, Colo.). Nukleonik, 7: 428(Aug. 1965).

The discrepancy between the accepted theoretical conditional detection probability for prompt neutrons and the experimental behavior lies in the experimental observation that the multiplying coefficient associated with the time-dependent portion of the prompt neutron conditional detection probability is independent of the prompt neutron population decay constant. An equation is derived for the prompt neutron conditional detection probability that expresses the dependence of the initial count upon the occurrence of the ancestor fission, thus directly relating the counting events at the two times of interest to their common antecedent. Experimental verification of this equation was obtained from the results of a series of experiments performed on the Cornell University zero power reactor. (J.S.R.)

1420 ON SYSTEMS OF INTEGRODIFFERENTIAL EQUATIONS OCCURRING IN REACTOR DYNAMICS [The-

sis]. Bronikowski, Thomas Andrew. Madison, Wis., Univ. of Wisconsin, 1965. 67p.

A determination is made of the existence, uniqueness, asymptotic behavior (as $t \to \infty$), and dependence on parameters of solutions, u(t), T(x,t), of the real integrodifferential system (1) $u'(t) = -\int_0^c \alpha(x)T(x,t)\,dx$, a $T_t(x,t) = b\,T_{\overline{xx}}(x,t) + \eta(x)u(t)$ where $0 < x < c$, $0 < t < \infty$, which satisfy the initial and boundary conditions (2) $u(0) = u_0$, $T(x,0) = f(x)$, $0 < x < c$; $T(0,t) = T(c,t) = 0$, $0 < t < \infty$. Here, α, η, f are prescribed functions defined on (0,c); a, b, c are positive constants; u_0 is an arbitrary constant; the subscripts denote partial differentiation; the prime denotes total differentiation. Two modifications of (1) and (2) are also studied. The first is the same as (1), (2) except that the boundary condition $T(0,t) = T(c,t) = 0$ is replaced by $T_x(0,t) = T_x(c,t) = 0$. In the second, the partial differential equation in (1) is replaced by a $T_x(x,t) = (b(x)T_x(x,t))_x + q(x)T(x,t) + \eta(x)u(t)$ where $a > 0$, $q(x) \geq 0$, $b(x) > 0$ for $0 < x < c$ and $b(x) \in C'(0,c)$, $q(x) \in C(0,c)$. (TCO)

Design and Feasibility

1421 (AD-611775) THE FLAME MASTER CONTROL SYSTEM. Cuthill, Elizabeth; Schot, Joanna W.; Kenady, Sarah E. (David Taylor Model Basin, Carderock, Md.). Jan. 1965. 93p. CFSTI $3.00 cy, $0.75 mn.

The operating system developed for the code-checking and production-running of FLAME, a three-dimensional few-group reactor depletion code for the DTMB UNIVAC-LARC is described. FLAME is actually a set of codes designated FLAME 1, FLAME 2, etc., each of which consists of many routines programmed for use in various combinations to solve a variety of steady-state and time-dependent problems arising in the design of nuclear reactors. The program which controls the combining of these routines into a flexible but efficient and practical system is known as the FLAME Master Control System. This system is also useful in processing LARC routines which are not part of the FLAME code. (auth)

1422 SPECIAL USE OF NUCLEAR POWER. Halzl, Jozsef. Energia Atomtech., 18: 187-9(Apr. 1965). (In Hungarian).

Papers at the Third Geneva Conference on specialized applications of atomic energy are discussed under three headings: desalination of sea water; atomic heating plants; and problems connected with the development of portable reactors. Economic investigations carried out in the United States and Israel revealed that, depending on the cost of fossile fuels, fresh water may be produced competitively by reactors with a capacity between 220 and 600 Mw. A 1000-Mw desalination reactor is planned by the Soviet Union to be located near the Caspian Sea. Two reactors were constructed primarily for space heating: in Halden, Norway and Stockholm, Sweden. Similar work is in progress in the Soviet Union, basing the design on that of the Beloyarsk power reactor. The portable reactors are designed for operation in remote areas where high fuel costs make them competitive. The United States has five such reactors in operation. These reactors are characterized by low weight, small dimensions, portability, ease of assembly, long core life, and simple operation and maintenance. Ship propulsion reactors include that of the icebreaker Lenin. Design work on maritime reactors is in progress in Holland, sponsored by Euratom and in West Germany. (TTT)

1423 DESIGN CONCEPTS FOR THE CORE STRUCTURE OF A MOSEL (MOLTEN SALT EXPERIMENTAL) REACTOR. Kasten, Paul R. (Oak Ridge National Lab., Tenn.); Gat, Uri; Schulze Horn, S.; Vornhusen, Heinz W. Nucl. Struct. Eng., 2: 224-32(1965).

General features of a MOSEL (molten salt experimental) reactor concept and a schematic flow diagram are given. A number of core designs appear capable of satisfying the requirements of such reactor. Interacting parameters which need to be evaluated as a function of operating conditions are permissible temperature distribution, stresses, nuclear performance, and fabrication possibility as a function of core design. In general it appears that plate type designs facilitate low friction of structural material, achievement of modular units, and fuel flow control. Tube-type designs appear advantageous relative to stress considerations and high fuel power density. (auth)

1424 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Hackney, Stanley; Potter, Ronald (to United Kingdom Atomic Energy Authority). British Patent 1,003,826. Sept. 8, 1965. Filed Jan. 22, 1962.

A reactor is described in which a liquid neutron-moderating transfer medium, the primary coolant, is employed as an intermediate layer between fuel elements in the reactor core and a reactor coolant, the secondary coolant. The fuel elements are housed in fuel tubes in which the primary coolant circulates. The secondary coolant is passed in mixed liquid and vapor phases outside the tubes. Unfuelled extension tubes are connected in series with each fuel tube. End connections may be used to interconnect adjacent fuel tubes and adjacent extension tubes to provide for the primary coolant a circulation path having fuelled sections alternating with unfuelled sections to equalize the heat transfer between the two coolants throughout the reactor core. (B.L.M.)

1425 NUCLEAR REACTOR. Williams, Ronald Peter; Hartwell, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,003,827. Sept. 8, 1965. Filed Feb. 4, 1963.

A design is described for a water-cooled reactor having between the core within the reactor vessel and the inner walls of the vessel a chamber through which the water coolant being recirculated to the core can pass to an inlet plenum below the core. The chamber is characterized by upright passages through which the recirculating coolant can pass in parallel with the chamber flow to the inlet plenum. The chamber is adapted for the flow through it to be slight. The passages represent only a minor portion of the volume of the chamber so that the recirculating coolant passing through the passages reaches the inlet plenum more quickly than would be the case solely by way of the chamber. The water occupying the chamber around the core may act as a reflector. (B.L.M.)

1426 IMPROVEMENT RELATING TO NUCLEAR REACTORS. (The Nuclear Power Plant Co., Ltd.; A.E.I.-John Thompson Nuclear Energy Co., Ltd.). French Patent 1,365,782. May 25, 1964. Priority date Aug. 8, 1962, Great Britain.

A nuclear reactor has a solid neutron moderating core and channels in the core in which fuel is located. Charge pans are provided on or near the surface of the core, with tubular members aligned with the channels. The charge pans are supported independently of the core, by means extending from the wall of the vessel so that they are unaffected by core movements or dimensional changes. (IIB)

1427 NUCLEAR REACTOR PLANT. (to Sulzer Brothers Ltd.). French Patent 1,382,728. Nov. 9, 1964. Priority date Mar. 20, 1963, Switzerland.

A nuclear reactor plant in which heat from the reactor is transferred to a working medium by heat exchange from a gaseous heat carrier which cools the reactor, is described. The pressure of the heat carrier in the heat exchanger means is higher than that of the working medium. The reactor plant has a number of parallel connected heat exchangers in the heat carrier circuit and shut-off elements by which the individual heat exchangers can be isolated from the heat carrier circuit. Means are provided for the detection, at least at intervals, of the presence of a heat carrier in the working medium in each heat exchanger. In this way a leaky part of the heat exchange surface can be rapidly detected and isolated from the remaining part of the heat exchange surface. (IIB)

1428 LIQUID FLUIDIZED BED NUCLEAR REACTOR AND METHOD FOR REDUCING PARTICLE ABRASION

THEREIN. Barr, Harold N.; Peterson, Donald H. (to Martin-Marietta Corp.). U. S. Patent 3,202,581. Aug. 24, 1965. Filed Jan. 20, 1960.

The introduction of powdered graphite into the fluidizing liquid of a liquid fluidized reactor serves to reduce the normal abrasion of the particles in the bed of the reactor. A graphite addition as small as 10% will serve to reduce particle erosion by a factor of 8, correspondingly increasing the effective life of the particles and decreasing the amount of fines produced. (B.L.M.)

1429 ORGANIC LIQUID MODERATED AND COOLED NUCLEAR REACTORS. Williams, Ronald Peter; Munn, Peter Neil; Duncan, Thomas R. (to United Kingdom Atomic Energy Authority). U. S. Patent 3,203,867. Aug. 31, 1965. Filed June 26, 1961.

An organic liquid moderated and cooled reactor comprises an upright pressure vessel of generally cylindrical form. A core structure and a shielding structure disposed below and around the core are located in the lower regions of the pressure vessel; a heat exchanger disposed in annular form about a hollow column extending downwards to the top of the core structure is located in the upper regions of the pressure vessel. The vessel is filled with the organic liquid immersing the core structure, the shielding structure, the heat exchanger, and a pump for causing the liquid to flow upwards through the core, along the column, through the heat exchanger, through and round the shielding structure, and thence to the core structure. The shielding provided in the shielding structure made of mild steel in conjunction with the shielding inherent to the organic liquid reduces activity at the surface of the vessel to a level not requiring shielding external to the vessel. (B.L.M.)

1430 NUCLEAR REACTOR INSTALLATION. Coudray, Michel; Treille, Pierre (to Society Indatom). U. S. Patent 3,205,140. Sept. 7, 1965. Priority date May 28, 1962, France.

An improved design for a solid-moderated, gas-cooled reactor includes the following advantageous features: an integrated heat-exchange construction, a sectionalized construction of the heat-exchange assembly, and an improved servicing facility in the form of a servicing chamber provided within the pressure enclosure of the reactor. The sectionalized construction of the heat-exchange assembly has provision for rapidly identifying a leaky section of the assembly and immediately isolating that section without shutting down the reactor. Following the isolation of the leaky section, the reactor can continue to operate with a relatively small drop in its power output until the next scheduled shutdown period when the leak can be easily repaired. The servicing chamber contains within it the connections from all the heat exchange tubes to the external circuit for the secondary fluid by means of which the isolation and repair of the defective tube(s) are greatly facilitated. (B.L.M.)

1431 REACTOR FUEL HOLD-DOWN ASSEMBLIES. Jabsen, Felix S. (to Babcock and Wilcox Co.). U. S. Patent 3,205,144. Sept. 7, 1965. Filed Aug. 25, 1961.

Design is provided for a heavy water reactor that employs spectral shift reactor control rather than control rods, and a filler casing within the reactor reduces the heavy water inventory needed to control the reactor. A hold-down arrangement is provided for the fuel elements that results in the reduction of structural material required to position the elements. A combination of fuel elements is provided, some having attached hold-down means that in turn provide hold-down for the other fuel elements against the lifting effect of the coolant flowing through the reactor. A thermal shield is made up of a number of separate individual sections that can easily be connected together to form a unitary structure. (B.L.M.)

1432 NUCLEAR REACTOR. Margen, Peter H. E. (to Aktiebolaget Atomenergi). U. S. Patent 3,205,145. Sept. 7, 1965. Priority date June 6, 1962, Sweden.

A nuclear reactor of the boiling water type, i.e., a reactor with boiling light or heavy water as a cooling medium, includes a comparatively thin-walled reactor tank with a water space and a steam space in the tank, a pressure-resistant vessel enclosing the reactor tank, and a gas-filled space between the reactor tank and the pressure-resistant vessel. Communication is provided between the steam space and the gas-filled space so as to equalize the pressures in the two spaces. Means are provided for withdrawing gas from the communication means and for removing any steam contained in the withdrawn gas by a cooler in which the steam is condensed. The dried gas is supplied to the gas-filled space. (B.L.M.)

1433 NUCLEAR REACTOR WITH COOLANT NON-RETURN VALVES IN PRESSURE VESSEL. Hackney, Stanley; Williams, Ronald Peter (to United Kingdom Atomic Energy Authority). U. S. Patent 3,205,146. Sept. 7, 1965. Priority date July 5, 1962, Great Britain.

A reactor is described that includes a reactor vessel, a core within the vessel, and a baffle surrounding the core defining a flow path downwards through the annular passage between the baffle and the reactor vessel and upwards through the core. A fluid-tight inner vessel surrounds the core within the reactor vessel into which the lower portion of the baffle projects so as to define an outlet from the inner vessel. An inlet into the inner vessel is disposed in the annular passage, and a nonreturn valve is provided at the inlet to counter the flow of reactor coolant out of the inner vessel through the inlet. When the design is applied to a boiling-water reactor, a steam dome is provided above the core to collect steam generated in the coolant in its passage through the core. (B.L.M.)

1434 NUCLEAR REACTOR CORE. Campbell, Ronald Hugh; Challender, Ronald Scott (to United Kingdom Atomic Energy Authority). U. S. Patent 3,206,370. Sept. 14, 1965. Priority date June 4, 1962, Great Britain.

A core arrangement for a reactor using hexagonal fuel elements clustered so as to be in contact with one another except at voids permitting coolant to flow over the elements comprises at least one full-group fuel assembly. The full-group assembly includes six similar sub-group assemblies arranged symmetrically to define a void. Each sub-group is made up of 21 elements arranged in a hexagonal group of 19 with the appendage of two elements to that side facing the void. The void so defined by a number of sub-groups serves as a control rod station. In each sub-group assembly the inner most element is a dummy that is removable to give access to a lifting attachment. (B.L.M.)

1435 GAS COOLED NUCLEAR REACTOR WITH IMPROVED COOLANT FLOW PATH ARRANGEMENT AND FUEL ASSEMBLY THEREFOR. Fortescue, Peter; Bell, Francis R. (to General Dynamics Corp.). U. S. Patent 3,207,670. Sept. 21, 1965. Filed Dec. 4, 1961.

An improved structure arrangement is provided for a high temperature gas cooled nuclear reactor core assembly that affords improved stability and durability of core components while permitting expansion of the components in the core. Improved fuel components contribute to increased efficiency of operation and are arranged for each removal and insertion into the core while undergoing minimal stresses. The compact core assemblies that are adaptable for use in various power output reactors permit semi-continuous refueling during operation and provide improved containment of fission products. (B.L.M.)

Fuels

Refer also to abstract 227.

1436 (GEAP–4907) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATED REACTORS. Final Report. Robkin, M. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 15, 1965. Contract AT(04-3)-189. 86p. (EURAEC–1469). Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The development and evaluation of a basic physics model for predicting the long-term changes in space and time in isotopic composition and reactivity of plutonium-enriched light-water-moderated reactors is described. A collateral irradiation is performed in the Vallecitos Boiling Water Reactor to provide burnup data against which to check the model. An experimental fuel element segment is fabricated from mechanically mixed PuO_2 and UO_2 powders, pressed and sintered into pellets. At 1860 Mwd/t, it is discovered that the segregation of part of the PuO_2 is more extensive than had been indicated in the pre-irradiation examination. The segregated PuO_2 particle distribution is investigated by autoradiography to determine the sizes and concentrations of the particles. The cross sections of all the isotopes in the burnup chain are computed by combining transport-theory calculations of the spatial variation of the thermal and the Pu-240 resonance cross sections with a multigroup calculation of the fast cross sections. The number of large plutonia particles per unit volume is determined. The cost of preparing fuel by the dry-blending technique is probably lower than for any other method. The results of the computation imply that advantage can be taken of these low fabrication costs without compromising the economic analyses of the fuel cycle. (auth)

1437 (GEST-2047) RESEARCH AND DEVELOPMENT PROGRAM OF THERMIONIC CONVERSION OF HEAT TO ELECTRICITY. Second Quarterly Technical Summary Report, September 30–December 31, 1964. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Dec. 31, 1964. Contract NObs-90417. 14p.

A research and development program on possible methods of electrically connecting one cell of a thermionic fuel element to the next one in series in a closely spaced coaxial arrangement is discussed. During this quarter fabrication was initiated, in accordance with the design of the first series-connected converter test assembly. Machining of most of the parts for this initial test assembly was completed. In addition, a number of trial pieces were fabricated to check out fabrication techniques and assembly procedures. Trial subassemblies of critical converter parts were made. Conceptual designs for a second series-connected assembly were initiated and subjected to analysis. (M.O.W.)

1438 AUTORADIOGRAPHY OF FUEL ELEMENTS OF THE KIWI REACTOR. AN EXPERIMENTAL NUCLEAR ROCKET ENGINE. Wagner, G. F.; Bahl, K. L.; Tenney, G. H. (Univ. of Calif., Los Alamos, N. Mex.). Mater. Evaluation, 23: 502-7(Oct. 1965).

The final phase of evaluating the performance of an experimental nuclear rocket engine consists of the study of many components once the reactor has been disassembled. An important phase of this postmortem study is the fission density distribution in individual fuel elements. Data on the possible existence of abnormalities among fuel elements which are indicative of unusual conditions of neutron flux and/or core temperatures or faulty performance of individual elements are presented. An autoradiographic technique was developed and applied to this study. Special jigs and instruments were designed in order to implement the technique to highly radioactive elements using remote operations in hot cells. The instruments, selection of films, automated film density read-out, and comparison of the data with those obtained from a collimated NaI (Tl) scintillator system are described. (auth)

1439 NUCLEAR FUEL PROBLEMS IN JAPAN. Nakamura, Yasuji (Atomic Fuel Corp., Tokyo). Nippon Genshiryoku Gakkaishi, 7: 506-10(Sept. 1965). (In Japanese).

The nuclear fuel problem in Japan is discussed. Imported uranium must be used as effectively as possible. Blending of enriched uranium with depleted uranium (extracted from spent fuel of light water reactors and still possessing a higher ^{235}U concentration than natural uranium) is shown to be economically practical and advisable. Further, the utilization of plutonium and the re-enrichment of depleted uranium should provide large savings in enriched uranium to be imported. (auth)

1440 OPERATING EXPERIENCE WITH THE SEMICONDUCTOR-GAMMA-COMPTON SPECTROMETER TO DETERMINE THE BURN-UP AND BURN-UP HISTORY OF NUCLEAR FUEL. Higatsberger, M. J.; Hick, H.; Rumpold, K.; Weinzierl, P.; Burtscher, A. (Osterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). Vienna, International Atomic Energy Agency, 1965, Preprint No. SM-67/7, 19p. (CONF-650803-23). ORINS.

From IAEA Symposium on Nuclear Materials Management, Vienna.

The quantitative reliability of nondestructive burnup determination by means of γ spectroscopy using a semiconductor detector in a Compton spectrometer has been tested. An MTR-type fuel element was irradiated under known conditions with inserted monitor wires. Neutron-physical evaluation of these monitors lead to a burnup value of 37.6 mg ± 7% ^{235}U for this fuel element. Nondestructive burnup determination with the Compton spectrometer yielded 36.1 mg ± 15% ^{235}U. A rough calculation of the reactor operating group based on thermal reactor power measurements and core position weight factors resulted in a burnup value of 40 mg ± 30% ^{235}U. During a routine run of one week a highly irradiated fuel plate cut into 18 separate pieces was measured. A comparison of these results with radio-chemical and mass analytical burn-up determination is presented. A test run covering 18 irradiated MTR-type fuel elements required another week of routine operation of the Compton spectrometer. By comparing relative intensities of γ energies related to fission products of different half lives further information on burnup history of the fuel under investigation can be extracted. (auth)

1441 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 1,002,244. Aug. 25, 1965. Priority date Feb. 12, 1963, United States.

A self-purging fuel element for a gas-cooled reactor has an elongated body that is permeable to the cooling gas. A bore extends through the body, and the body has one or more fuel-containing chambers. There is a restriction in the bore, and the chambers are in fluid communication with the bore adjacent to the restriction. Preferably, the gas-permeable body is formed of graphite having a He permeability of 10^{-2} to 10^{-3} cm^2/sec and has a pore structure that resists back diffusion of fission products. The restriction in the bore of the elongated body is formed by a venturi plug, and the fluid communication between chambers is formed by at least one passageway through the plug. The fuel comprises discrete particles of a fissionable fuel having a fission product coating on them and is disposed in the fuel-containing chambers. (B.L.M.)

1442 NUCLEAR FUEL ASSEMBLY. Johnston, Charles (to Societe Angle-Belge Vulcain, S.A.). British Patent 1,002,784. Aug. 25, 1965. Filed June 5, 1963.

A nuclear fuel assembly is made up of a number of fuel pins supported in a bundle with their longitudinal axes parallel and a support plate to which the fuel pins are secured. The means to secure each pin to the support plate comprises a peg projecting axially from one end of the pin. The peg is formed with a hollow end portion, and a shoulder is formed between the pin and the peg. A hole in the support plate is penetrated by the peg to an extent limited by the shoulder. A pinched deformation of the hollow portion of the peg engages the support plate on the side remote from the shoulder. Preferably, the deformation extends into the hole in the support plate to an extent determined by the axial length of the hollow portion of the peg. (B.L.M.)

1443 FUEL ELEMENT FOR NUCLEAR REACTOR. Boudouresques, Bernard; Maillet, Ennemond; Pelce, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,003,446. Sept. 2, 1965. Priority date July 6, 1962, France.

A fuel element of tubular shape and having inner and outer cans and being cooled in operation by a fluid that circulates both externally and internally of the element is described. The mean diameter of the element is not more than half of the internal diameter of the fuel element channel. The inner surface of the can has a coefficient of friction of from one-fifth to one-twenty-fifth that of the outer surface of the outer can. The configuration is such that the surface offers to the flow of the fluid a resistance per unit area 1½ to 6 times as great as that of a smooth surface. The inner surfaces of the inner can may also be provided with fins or corrugations in various patterns or orientations. (B.L.M.)

1444 MEASURING APPARATUS. (to United Kingdom Atomic Energy Authority). French Patent 1,261,675. Apr. 10, 1961. Priority date July 3, 1959, Great Britain.

In order to determine whether the weight of a column of fuel-pellets lies within predetermined tolerance limits, a measuring apparatus is used. The apparatus comprises a channel member which can be supported horizontally by a pivot at one point and by resiliently deflectable means at another point on its length. The pivot is allowing the channel member to rotate in a vertical plane. Other means are provided for measuring the degree of angular deflection of the channel member under the weight of the column of pellets to provide indication, whether the weight of the column of pellets lies within predetermined tolerance limits. (IIB)

1445 NUCLEAR REACTOR FUEL ELEMENT. Ritz, Heinrich Hugo Ludolf; Elliott, Edward Rae (to C. A. Parsons and Co. Ltd.). German Patent 1,194,511. June 10, 1965. Priority date Nov. 16, 1955, Great Britain.

The tubular can of the fuel element is provided with longitudinal, undulated fins. The straight grooves obtained by said undulation are inclined in relation to the axis of the fuel elements. The inclination of the grooves of opposing fins is directed in opposite directions. (Gmelin Inst.)

1446 FUEL ELEMENT FOR NUCLEAR REACTOR. Kumpf, Hermann; Kroepfl, Hans; Huber, Benno (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,195,877. July 1, 1965. Filed May 19, 1960.

The nuclear fuel element comprises a bundle of fuel rods supported between two end plates which are provided with coupling elements and enable the joining of two fuel elements in axial alignment. The end plates and the coupling elements are constructed in the shape of one half of the coupling in such a way that by coupling two and more fuel elements together a rigid pillar is obtained which can be dismantled within the reactor vessel by means of a gripping device. (Gmelin Inst.)

1447 REACTOR WITH THICKENED FUEL SUSPENSION CIRCULATED THROUGH TUBES. Helmis, Guenther; Schimmel, Wolfgang; Meyer, Klaus (to VEB Atomkraftwerk Rheinsberg). German Patent 1,195,878. July 1, 1965. Filed July 15, 1959.

In order to prevent deposits, bodies of polyhedral structure are added to the suspension. These bodies are made of an absorber, a moderator, or a material which is neither an absorber nor a moderator but which doesn't react either with the suspension or with the wall material of the tubes. The diameter of the bodies is only a little smaller than the smallest inner diameter of the tubes. (Gmelin Inst.)

1448 FUEL ELEMENT FOR NUCLEAR REACTOR. Ott, Karl (to Gesellschaft fuer Kernforschung m.b.H.). German Patent 1,196,800. July 15, 1965. Filed Nov. 2, 1962.

The fuel element consists of a sheathed, thick-walled and hollow cylinder which is provided with conical, radially directed recesses into which the fuel is inserted. (Gmelin Inst.)

1449 TUBULAR CONTAINER FOR NUCLEAR FUEL. Ritz, Heinrich Hugo Ludolf; Elliott, Edward Rae (to C. A. Parsons and Co. Ltd.). German Patent 1,200,449. Sept. 9, 1965. Priority date Oct. 25, 1955, Great Britain.

A cylindrical can has on its outside surface helical heat transfer fins and longitudinal splitter fins. The splitter fins extend radially beyond the helical fins. (Gmelin Inst.)

1450 METHOD OF MAINTAINING SHEATHING CONTACT IN HOLLOW FUEL ELEMENTS DURING NUCLEAR REACTOR OPERATION. Salesse, Marc; Stohr, Jacques Andre; Gauthron, Maurice (to Commissariat a l'Energie Atomique). U. S. Patent 3,202,583. Aug. 24, 1965. Filed May 3, 1960, France.

A method is described for maintaining contact between inner sheaths and hollow cylindrical fuel portions in a reactor cooled by a heat exchange fluid. An outer sheet is formed about and in contact with the external surface of the hollow fuel portion, and an inner sheet is in engagement with the inner surface of the fuel portion until thermal expansion of the fuel portion separates it from the inner sheet. The heat exchange fluid is pre-heated by contact with the fuel portions, and then the heat and pressure applied by the recirculation of the heated heat exchange fluid forces the inner sheet into thermal engagement with the fuel portion after thermal expansion of the fuel portion. (B.L.M.)

1451 FUEL ELEMENTS FOR NUCLEAR REACTORS. Fortescue, Peter; Lockett, George Edward (to United Kingdom Atomic Energy Authority). U. S. Patent 3,206,369. Sept. 14, 1965. Filed June 15, 1961.

A reactor fuel elements assembly consists of a number of elements having tubular graphite containers held together by a spider-like member. The tubular graphite containers are engaged at the ends by the spider-like members to hold the elements in parallel relation. One spider-like member defines a manifold communicating with the interior of each of the tubular containers through ducts for ventilating volatile fission products and coolant that permeates through the container wall. The other spider-like member has means connected to it to be engaged by grappling means and means for conducting the vented fission products and coolant away from the reactor core. (B.L.M.)

Power and Power-Breeder Reactors

1452 (ACNP–63628) ERR STACK MONITOR STUDY. Sarigianis, Perry (Allis-Chalmers Mfg. Co., Washington, D. C. Atomic Energy Div.). Dec. 1963. Contract AT(11-1)-654. 15p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Two tests were performed at the Elk River site to determine how best to increase the range of the stack monitor to cover the proposed activity release limits. Results of these tests determine the required changes to extend the overall radiation monitoring range. The results are presented. (M.O.W.)

1453 (ACNP–65532) ELK RIVER REACTOR OPERATIONS ANALYSIS PROGRAM. Semi-Annual Progress Report, July 1, 1964–December 31, 1964. Fisher, J. R.; Kendrick, E. D.; Kruzic, T. P.; Schafer, A. C. Jr. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-1357. 89p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

During the report period the reactor heat generated was 3475.4 Mwd and the net electrical generation was 31,648 Mwhr. Automatic control of the reactor, superheater, and turbine-generator complex was demonstrated, and a 60-day period for the turnover of operating functions to RCPA was completed. The reactor plant was shut down in October for inspection of the control rods and control-rod drives, in accordance with the technical specifications. These components were found to be in good condition, and plant operation was resumed in December. Operation of the reactor plant was satisfactory. Operating data were used to evaluate the performance of the plant energy transfer and primary auxiliary systems. Plant operating data are in general agreement with the design parameters. Typical data are included. Additional evaluations included studies of de-

contamination and waste disposal requirements and cask handling and storage operations. A tabular summary of ERR operation during this report period is included. (J.R.D.)

1454 (AECL–2293) THE FUTURE OF NUCLEAR POWER IN CANADA. Gray, J. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 1965. 20p. (CONF-650944–1). AECL Free.

From Japan Atomic Industrial Forum, Tokyo.

The progress toward the objective of economic nuclear power in Canada is discussed. The CANDU system and the projected change from pressurized heavy water to boiling light water are described. The present status of nuclear power is given, and future prospects are considered. It is felt that advanced converters with thorium fuel cycle can be used instead of fast breeders in the future. (D.L.C.)

1455 (AWRE-R–3/65) AN ASSESSMENT OF REACTOR SAFETY MODELLING TECHNIQUES BASED ON THE ACCIDENT TO THE SL-1 BOILING WATER REACTOR. Warren, G. R.; Rice, T. W. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug. 1965. 41p. Dep.; BIS $1.80; HMSO 9s. 0d.

The published results of the SL-1 accident were used as a yardstick to assess the reliability of model scale techniques to be used for the safety evaluation of water reactors. (auth)

1456 (BNL-9475) SOME SAFETY CONSIDERATIONS BASED ON DESIGN EXPERIENCES IN THE BNL SETTLED BED FAST REACTOR CONCEPT. Lellouche, Gerald S.; Levine, Melvin M.; Chernick, Jack (Brookhaven National Lab., Upton, N. Y.). Aug. 1965. Contract AT(30-2)-Gen-16. 8p. (CONF-651009-1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Conference on Safety, Fuels and Core Design in Large Fast Power Reactors, Argonne, Ill.

The sodium regions above and below the core of the SBFR are described. Diagrams are given showing the local sodium expansion coefficient at power as a function of position, the time behavior of the reactor power when the inlet sodium temperature is reduced 100°C and maintained at that lower temperature, and the core sodium temperature at several positions as a function of time for the same perturbation. These diagrams are briefly discussed. (M.O.W.)

1457 (BNWL–126) THE PuO_2–UO_2 EXPERIMENT IN THE EBWR. Liikala, R. C.; Jenquin, U. P.; Reardon, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 9, 1965. Contract AT(45-1)-1830. 52p. Dep. mn; CFSTI $3.00 cy, $0.50 mn.

A plutonium experiment to demonstrate the utilization of plutonium in a light-water moderated power reactor is outlined. A series of tests will be conducted during the initial loading of the EBWR in order to measure the reactivity worth of fuel rods, safety rods, voids, and boric acid in the moderator. The results of calculations of the reactivity changes expected at startup and throughout the burnup of the core are presented. Information obtained during the actual startup experiments will be used to assess the accuracy of the calculational methods and identify areas of uncertainty in the computations. (M.O.W.)

1458 (BNWL-SA–308) ACCOMPLISHMENTS OF THE PLUTONIUM RECYCLE TEST REACTOR. Purcell, R. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 3, 1965. Contract AT(45-1)-1830. 31p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The PRTR was described and highlights of its progress in the field of plutonium recycle development were presented. Its contributions to reactor and fuel technology in general were pointed out and the forthcoming High Power Density Core operation was discussed. (M.O.W.)

1459 (CEND-515) REACTOR OPERATIONS SAFETY ANALYSIS FINAL REPORT TO RURAL COOPERATIVE POWER ASSOCIATION. (Combustion Engineering, Inc., Dunedin, Fla. Nuclear Div.). Nov. 1964. Contract AT (11-1)-651; Subcontract No. 2. 129p. Dep. mn; CFSTI $4.00 cy, $1.00 mn.

Discussions on the Elk River Reactor (ERR) consist of the following: reactor safety, technical specifications, operating procedures, reactor physics characteristics, thermal characteristics, reactor noise and stability, water chemistry, radioactivity levels in significant point in the plant, safety monitoring program, procedures for liaison with Rural Cooperative Power Association, and methods of carrying out the safety monitoring program. A draft of revised technical specifications of the ERR is included in the appendix. (M.O.W.)

1460 (CONF–650407, pp 1015-34) CONTAINMENT AND SITING OF HIGH POWER REACTORS. Shirvaikar, V. V.; Ganguly, A. K. (Atomic Energy Establishment, Trombay (India)).

The problems of siting such very high-power reactors are different from those encountered in siting of reactors of a few hundred Mw (electrical) capacity. Environmental safety can no longer be ensured through taller stacks or large exclusion distances. It has to be provided through engineered safeguards by improved containment of induced gaseous activity during normal operation and the noble gas and volatile fission products in the event of a serious accident and core melt. The concept of Acceptable Release in Emergency (ARE) was used to assess: the requirements of containment capability of very high-power reactors and their siting problems; technological feasibility of attaining the required containment capabilities; and the relative merits from safety considerations, of a station having a single very high-power reactor and a station consisting of a number of medium-power units. (D.L.C.)

1461 (CONF–650407, pp 1035-56) A PROBABILISTIC METHODOLOGY FOR THE SAFETY ANALYSIS OF POWER REACTORS. Mulvihill, Robert J.; Reed, Frank C. (Planning Research Corp., Los Angeles, Calif.).

A probabilistic methodology was developed for use in the evaluation of hazards associated with light water-cooled and -moderated power reactors. The methodology consists of a series of mathematical models that describes both the probabilistic aspects of the occurrence of an accident and the probabilistic aspects of the accident consequences in terms of fission product release. This methodology evaluates the probability distributions of the integrated dose, the maximum dose rate, and damage as a function of position external to the reactor and time. Instructions for programming the methodology on the IBM-7094 computer were prepared. The methodology was applied to the analysis of two types of accidents. The reactor utilized for this analysis was the Yankee Reactor at Rowe, Massachusetts. (D.L.C.)

1462 (CVNA–243) MONTHLY OPERATING REPORT, AUGUST 1965. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Contract AT(30-1)-2289. 31p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The general plant performance for August 1965 is discussed. Discussions are given on plant chemistry—a general summary of the significant chemistry work with a tabulation of analyses performed, plant maintenance—a listing of the major maintenance work performed, (instrument, mechanical, and electrical repairs) and changes or additions to plant, and health and safety—a summary of plant radiological, general safety, industrial hygiene, fire prevention, and medical work performed including environmental monitoring statistics. (M.O.W.)

1463 (EUR-2445.f) CONSOMMATION ET PRODUCTION DE MATIERES FISSILES PAR DIFFERENTS TYPES DE REACTEURS DE PUISSANCE. (Consumption and Production of Fissile Materials by Various Types of Power Reactor). Parker, E. (European Atomic Energy Community). 1965. 12p. (CONF-631006-1). Dep. mn.

From Symposium on Long-Term Aspects of the Development of Nuclear Energy in the European Community, Venice.

The requirements of natural and enriched uranium for the various existing power-reactor types in Europe are

stated, as well as the conditions of plutonium production by these reactors. The problem of plutonium consumption in fast reactors is discussed. The study of this problem will enable this reactor string to be compared with the existing reactors from the standpoint of fissile material supplies. (M.O.W.)

1464 (GAMD-6364) CONTROL ROD ANALYSIS—EFFECT OF MESH SPACING AND BOUNDARY CONDITION LOCATION IN BOTH ONE AND TWO DIMENSIONAL ANALYSIS. Lane, R. K. (General Atomic, San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science). May 5, 1965. Contract AT(04-3)-314. 23p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Comparison studies were made for a typical HTGR control rod cell in both one and two dimensions to evaluate the effects on predicted rod worth of mesh point spacing and the positioning of the current-to-flux rod boundary condition used in these studies. With current-to-flux boundary conditions obtained from the reference GAPLSN transport code, rod cells were analyzed with both the GAZE (1-D) diffusion code and the GAMBLE IV (2-D) diffusion code with the following results. The control swing as predicted by GAMBLE IV was almost identical to the GAPLSN reference value independent of the mesh spacing around the rod, i.e., between 0.5 and 4.2 cm spacing, when the boundary condition was applied at the guide tube outer radius. An overprediction in control reactivity swing of 9.3% resulted when the boundary condition was applied at the rod poison surface. The GAZE one-dimensional cell results predict a control swing 5.5% too high with the boundary condition applied at the rod surface and also show a much stronger dependence on mesh point spacing. An overprediction of 14.3% in the control swing results when the mesh spacing is increased to 4.2 cm around the rod. The reason for the strong mesh size dependence in the GAZE code was investigated and is discussed. (auth)

1465 (GEAP-4894) HIGH POWER DENSITY DEVELOPMENT PROJECT. Twentieth Quarterly Progress Report, March–May 1965. Holladay, R. L. (comp.). (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). June 1, 1965. Contract AT(04-3)-361. 26p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Reduction of the data obtained from the terminal post-irradiation examinations and tests of Type 304 stainless steel clad fuel rods is in progress. A band in irradiated cladding samples near the cladding-UO_2 fuel interface was not identified; electron microprobe analysis of the unidentified band was initiated. Dimensional profiles were obtained on irradiated fuel rods which had previously been removed from developmental assemblies D-1 (Zircaloy-2 clad, free-standing 0.030-in. wall, pellet UO_2), PE-2 (Type 304 stainless steel cladding, collapsed 0.010-in. wall, pellet UO_2), and PO-3 (Type 304 stainless steel cladding, collapsed 0.010-in. wall, powder UO_2). Experiments were performed to determine if the nonadherent crud films on these fuel rods would affect the profile traces. No differences could be detected between profile traces obtained with and without the adherent crud film on the fuel rod surfaces. Reduction of all control rod oscillation data from the Phase I and Phase II tests at Big Rock Point is complete. Analysis of these data is underway to allow comparison of the effects of the important operating parameters on stability margin. A core configuration was selected and parameter defined for the operation of a 600 Mw(e) high power density reactor. Various developmental features are still under consideration for the final design. Work was performed on two on-demand programs for the on-line computer at Big Rock Point. It is expected that these programs will be made operational during the next quarter. The Big Rock Point reactor was shut down through this report period. (J.R.D.)

1466 (HPR-63) HBWR QUARTERLY PROGRESS REPORT, APRIL TO JUNE 1965. (Institut for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). July 1965. 138p. Dep. mn.

Operation of the HBWR is summarized along with shutdowns. One shutdown was caused by leakage in the electrical level feeler gage (the dropstick). This unit was removed. Work is described on calibration of tubular fuel elements, during which British test elements IFA-6 and IFA-8 failed. Information is included on activity release caused by fuel elements, fission gas collection system design, and burnup experiments. Research on reactor statics and reactor dynamics is summarized. Irradiation testing of fuels is described, and developmental programs are discussed. (J.R.D.)

1467 (IDO-28649) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM QUARTERLY PROGRESS REPORT, APRIL 1–JUNE 30, 1965. (Aerojet-General Nucleonics, San Ramon, Calif.). Aug. 13, 1965. Contract AT(10-1)-880. 106p. Dep. mn; CFSTI $4.00 cy, $0.75 mn.

The technical progress on the development of a mobile, low-power nuclear power plant for military field operation is discussed. The repair of the ML-1 pressure vessel leak was completed and a series of low power tests for rod calibration and reactivity coefficient determination was completed. During these tests, an analog computer was connected to selected reactor operating instrumentation systems to permit the direct derivation of rod calibration curves and reactivity coefficient values. Control rod position indicator systems with high precision were installed prior to the initiation of testing. The assembly of the fin-plate precooler for the ML-1 was completed and tests of the air-side system revealed that the air flow rate was approximately 20% greater than the design value. The testing of the alternator at the vendor's shop was essentially completed by the end of June. The test program to check out and calibrate the various components of the GDF lubrication system was initiated. The metallurgical evaluation of the failed pin from the IB-17R-3 test element revealed that the failure resulted from the oxidation of a defect in the cladding. The defect was identified and attributed to the fabrication process rather than to any condition existing during irradiation. The balance of the IB-17R-3 test element was shipped to PPCo/NRTS for hot cell examination. The fabrication of 20 ML-1-IM fuel elements continued. The limited evaluation of ML-1 pressure vessel technology was completed and the conceptual design of an advanced pressure vessel was developed. The study to evaluate methods for optimization of the ML-1A shielding was completed. The GCR Facility modification was completed. (auth)

1468 (JPL-TR-32-741) DESIGN STUDY OF A FISSION-ELECTRIC CELL REACTOR. Shapiro, Jerome L. (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena). Aug. 1, 1965. Contract NAS 7-100. 20p.

A design approach is developed for the application of a fission-electric cell reactor to the generation of power in space. For a graphite-moderated reactor, the total size, temperature, and total (thermal) power are fixed. The remaining parameters, including cell dimensions and voltage, are then selected to optimize the overall efficiency. To simplify the calculations, two-group reactor theory is used, investigating both the single-region and two-region core concepts. From the standpoint of overall efficiency, it is shown that the two-region core is advantageous only for low-efficiency systems and hence offers little promise. Another important result of these calculations is that the optimum operating voltage is shifted downward from the optimum as calculated without considering criticality limitations. This means that the maximum efficiency achievable is reduced considerably and indicates that the criticality requirement may be a more severe limitation on efficiency than the effect of voltage breakdown within the cell. (auth)

1469 (KFK-359) THE FUTURE UTILIZATION OF NUCLEAR ENERGY IN EUROPE. Wirtz, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Aug. 1965. 49p. Dep. mn.

Questions on various aspects of reactor technology were submitted to Belgium, United Kingdom, France, Italy, Switzerland, Spain, and the Federal Republic of Germany. Summaries of their replies to these particular questions

are presented. The nuclear fuel requirements and the cost structure of nuclear energy development were briefly discussed. (M.O.W.)

1470 (NP–15407) O.E.C.D. HIGH TEMPERATURE REACTOR PROJECT DRAGON. SIXTH ANNUAL REPORT, 1964–1965. (European Nuclear Energy Agency, Paris (France)). 123p. Dep. mn.

Progress is reported on reactor physics, engineering research, C transport, coolant processing, fuel element production, graphite development, fuel development, fuel coating research, and irradiation testing. Reactor construction and commissioning are summarized along with reactor operation and assessment. Aspects of administration are also summarized. (J.R.D.)

1471 (ORNL-TM–1282) EXAMINATION OF BONUS PREHEATER-DRYER PIPING. Long, E. L. Jr. (Oak Ridge National Lab., Tenn.). Oct. 1965. Contract W-7405-eng-26. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Four sections of piping from the preheater-dryer system of the Boiling Nuclear Superheat (BONUS) Power Station were examined at ORNL for possible defects. This examination consisted of ultrasonic inspection of the piping and metallographic examination of possible defect regions as well as other regions of interest. Examination of suspected defect regions confirmed that a high degree of reliability could be placed on an ultrasonic inspection performed on the piping while still in the reactor. All indications of defects recorded during the ultrasonic inspection were found to be either the result of incomplete fusion in the weldments or cracks in the piping. Various chemical analyses were performed on samples taken from the elbows and header of this system for material verification. Several of the elbows in the piping contained carbon in the range of type 302 stainless steel rather than the specified type 304L stainless steel. Analysis of scrapings from the inner surface of a pipe showed the chloride-ion concentration to be less than 0.3 $\mu g/cm^2$. (auth)

1472 (RT/ING(64)12) ELEMENTO DI COMBUSTIBILE STRUMENTATO PER IL REATTORE P.R.O. (Instrumented Fuel Element for the P.R.O. Reactor). Cesari, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Oct. 1964. 111p. Dep. mn.

Instrumented fuel elements for the PRO project are discussed. Four different types of rod extensions were examined; rod with probe, rod with connector plug, rigid rod, and articulated rod. The thermal calculations necessary to determine the axial and transversal temperature profile for the various elements and the estimate of the hydraulic anomalies and of the neutron flux distributions are included. The preliminary and final design of these instrumented fuel elements are given in report RT/ING (64) 12 bis. (M.O.W.)

1473 (RT/ING(64)12bis) ELEMENTO DI COMBUSTIBILE STRUMENTATO PER IL REATTORE P.R.O. (allegati). (Instrumented Fuel Element for the P.R.O. Reactor (Enclosures)). Cesari, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Oct. 1964. 170p. Dep. mn.

The preliminary and final design of several types of instrumented fuel elements pertaining to the PRO project are included. (M.O.W.)

1474 (STI/DOC/10/42, pp 59-60) STUDIES INVOLVING REACTORS. (International Atomic Energy Agency, Vienna (Austria)).

Analog studies were made of the stability of several power reactor types: pressurized-water, boiling-water, and heavy-water. (D.L.C.)

1475 (TID–22223) 237 MW KRB NUCLEAR POWER PLANT. Quarterly Report No. 7, October 1–December 31, 1964. (Kernkraftwerk RWE-Bayerwerk G.m.b.H., Gundremmingen (West Germany)). 125p. (KRB–1964/4). Dep. mn; CFSTI $4.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Various aspects of the overall development of the KRB nuclear power plant are discussed in detail. The discussions include the diagrammatical representation of construction status, status of total project, work schedule, personnel employed on site, photographs, financing, contracts awarded, and a list of reports, specifications, and drawings. (M.O.W.)

1476 (TID–22288) CONNECTICUT YANKEE ATOMIC POWER COMPANY DESIGN AND ENGINEERING ANNUAL REPORT, JULY 1964–JUNE 1965. TITLE I AND TITLE II. (Connecticut Yankee Atomic Power Co., Haddam). Aug. 1965. Contract AT(30-1)-3250. 75p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Progress on the design and development of the Connecticut Yankee Power Reactor and surrounding facilities during the period July 1964–June 1965 is reported. Discussions are given on the development of the site and environmental surveys, nuclear design, structural design, fuel handling, engineered safeguards, instrumentation and control, turbine plant design, electrical design, and computer planning. (M.O.W.)

1477 (WAPD-PWR-TE–166) SPECIAL THERMOCOUPLE PERFORMANCE PWR-1, SEED 4. Renner, H.; Smeltzer, P. (Bettis Atomic Power Lab., West Mifflin, Pa.). Oct. 1964. Contract AT(11-1)-Gen-14. 47p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Twelve chromel-alumel thermocouples were installed above the coolant channels of two seed type fuel assemblies of PWR-1 Seed 4. The thermocouples were monitored hourly throughout seed life to obtain a better measure of the power distribution across the instrumented fuel subassemblies than could be obtained from the standard core thermal instrumentation. Significant differences in local power density were measured within and between the two fuel assemblies. (auth)

1478 ADVANCED AUTOMATION FOR EL-4, THE NEW NUCLEAR POWER STATION AT MONTS D'ARREE. Automatisme, 9: No. 9, XX(Sept. 1964).

An advanced system of automation through centralized data processing is planned for the Monts d'Arrée power station EL-4 now being built at Brennilis in the Finistère department. The equipment, which will perform conventional operating calculations related to the monitoring and recording of magnitudes, will also automatically control the main regulating loops by acting directly on the settings. In addition, startups, any changes in the running conditions, and stops will be under the complete control of the computer, which will make allowance for the overall state of the power station at the instant considered, for each decision. This equipment consists of a high-speed CAE-530 digital computer, a high-capacity external store (magnetic drum), a device for scrutinizing and digital-analog coding, and a great many auxiliary units. The total number of magnitudes of all kinds to be processed is over 4,000. Certain of them are scanned at a rate of over a 100,000 per second. The degree of automation of this set of operations, performed with all desirable speed and safety, constitutes a major safety factor. (French Technical Press, No. 1, 1965)

1479 THE PRESSURE VESSEL OF E.D.F. 1 POWER STATION AT CHINON. Saget, P. Construction (Paris), 19: 325-9(Nov. 1964).

The pressure vessel of the EDF-1 Power Station at Chinon, consisting of a completely hermetic spherical steel building was designed to isolate the reactors and heat exchangers from the outside in order to retain, if necessary, any radioactive gases that might be released following an accident. The design of the pressure vessel is explained and compared with foreign structures. The construction work is then described. (French Technical Press, No. 1, 1965)

1480 PARTICULAR ASPECTS OF THE ARDENNE NUCLEAR POWER PLANT. Erkes, P.; Grau, P. Electricite, No. 123, 1-16(June 1965). (In French).

The Ardenne Nuclear Power Plant is a pressurized water reactor with nominal power of 266 Mw(e) and a thermal

power of 905 Mw. The technical characteristics and the present state of construction of the reactor are reviewed. The economic prospects for the power station with respect to the investment, fuel cost, insurance, and operation and their effect on the total cost kwh are indicated. (J.S.R.)

1481 THE PRESENT STATE AND PROSPECTS OF UTILIZING NUCLEAR POWER. Levai, Andras. Energia Atomtech., 18: 121-34(Apr. 1965). (In Hungarian).

During the last 6 years dozens of atomic power stations, with a total capacity of about 5000 Mw(e), were built; their operating experience offers a basis for economic evaluation of their performance. It was concluded from data on these stations that the cost of the nuclear-generated electricity and heat is becoming competitive with energy derived from conventional sources, even though government subsidies played an important role in the development of the present plants. The main factors that contributed to the increasing importance of atomic power plants include: use of large reactors, up to 600 Mw; increasing cost of conventional fuels; prolonged periods of exploitation of the atomic power plants, and inclusion of these plants in interconnected networks. It is forecast that by 1970 about 25,000 Mw(e) and by 1980 up to 250,000 Mw(e) atomic power plant capacity will be available. Desalination of seawater is postulated to be one of the chief potential fields of application of atomic energy that will probably become completely competitive with other systems within the next two decades. (TTT)

1482 POWER STATIONS WITH GAS-GRAPHITE REACTORS. Bueki, Imre. Energia Atomtech., 18: 135-41 (Apr. 1965). (In Hungarian).

The importance of gas-cooled, graphite-moderated reactors for power stations is illustrated by the fact that more electricity is generated by this type alone than by all other reactor types together. The first generation of reactors of the United Kingdom and French programs are based exclusively on this type. Operating experience gained with the Calder Hall and Chapelcross Pu-producing reactors and with the Berkeley and Bradwell power stations revealed that the gas-graphite reactors are safe and reliable even under severe winter conditions prevailing during 1962/63. The difficulties experienced were due to the nonnuclear components, such as heat exchangers or turbines. In the United Kingdom, attempts were made to increase the gas inlet and outlet temperature in order to improve the efficiency; superheat by fossile fuels was also examined. In the British reactors, the CO_2 flows upward in vertical chambers, while the French carried out experiments with horizontal cooling chambers, requiring a more complex flow path for the coolant. Use of large, standardized reactors appears to be desirable. Recent French calculations for reactors planned for 1966-70 are based on an investment figure of 1200 Francs/kw, an amortization period of 20 years, a burnup level of 3500 Mw day/ton and a use factor of 65% and a fuel cost of 1.2 centime/kw hr; for comparison, conventional power stations are designed for a 680 francs/kw specific investment and a fuel cost of 2.38 centimes/kw hr. (TTT)

1483 NUCLEAR POWER PLANTS WITH WATER COOLED REACTORS. Varadi, Vilmos. Energia Atomtech., 18: 142-52(Apr. 1965). (In Hungarian).

Power stations under construction based on PWR-type reactors reach a total capacity of 3250 Mw(e) according to papers presented at the Third Geneva Conference. The reactors of the Indian Point and Novovoronezh power plants represent advanced design. The core, fuel elements, control system, cooling system, radiation protection and heat generation methods of these two reactors are compared. On the basis of experience gained with these reactors and others, some conclusions were drawn. The size of the vessel was found not to present any technological problems; it is limited by other considerations, such as ease of transportation. The core design tends toward simplicity, resulting in improved economy and ease of maintenance. High burnup did not adversely affect the fuel. UO_2 fuels did not cause any difficulty and experiments with U–Pu fuels were found to be promising. Control systems based on the use of highly absorbing materials in the rods affects the economy of the core; chemical control based on dissolved boric acid may be used to compensate for reactivity changes due to burnup. At an average load factor of 79%, the generated electricity is competitive with that produced by soft coal. (TTT)

1484 VAPORIZING REACTORS WITH WATER COOLING. Raszl, Karoly. Energia Atomtech., 18: 153-65(Apr. 1965). (In Hungarian).

The development of the BWR-type reactor was aimed at the solution of two problems: improvement of heat transfer within the reactor's cooling channel and elimination of the heat exchanger that separates the primary and secondary circuits of the PWR system. The reactors developed in the United States and in the Soviet Union have only their cooling method in common; their other characteristics are different. In the American BWR light water serves as moderator and coolant, while in the Russian Beloyarsk reactor graphite moderator and pressure pipes are used. On the basis of the operating experience of EBWR, VBWR, and Borax reactors, the Dresden reactor was designed to demonstrate the reliability of large boiling water cores; the first reactor of the Russian Kurchatov power plant was built for the same reason. These two reactors are compared on the basis of their operating efficiency, power generating circuits, core vessel geometry, control rods and drives, core design, fuel element development, containment, storage of radioactive wastes, personnel protection, and economy. (Review article, 18 references) (TTT)

1485 HEAVY WATER AND ORGANIC REACTORS. Halzl, Jozsef. Energia Atomtech., 18: 166-76(Apr. 1965). (In Hungarian).

Heavy-water-moderated reactors have the advantage of making possible the use of natural U, thus reducing fuel cost; in addition, they can be easily controlled and present good breeding possibilities. On the other hand, the dimensions of these reactors are quite large and the cost of heavy water and of the devices needed to minimize losses of heavy water tend to render the operation expensive. Use of organic materials makes it possible to employ inexpensive structural materials and the low level of activation reduces the need and cost of radiation protection equipment. However, organic materials possess a low thermal conductivity and tend to decompose under irradiation. The heavy water and organic reactors built, proposed, or under construction are tabulated. The design of the Swedish R3/Adam reactor is reviewed. This 13- to 65-Mw reactor yields steam at 196 to 215°C. In the Canadian heavy water reactor possessing a pressure vessel, the coolant circuit is separated from the moderator. The NPD uses natural U fuel; it experienced only moderate D_2O losses and reached a satisfactory burnup level. The fuel elements were successfully replaced during operation. Boiling-water reactors, moderated with D_2O and boiling H_2O were constructed in the United Kingdom and Canada. Gas-cooled and heavy-water-moderated reactors are being developed in France, Switzerland, Czechoslovakia, and West Germany. Studies in the United States, Canada, and Spain revealed serious design difficulties in the D_2O-moderated and organic-cooled reactors. Work on the organic-moderated and -cooled reactors was suspended in the United States but this design continues to receive attention in Italy and Canada. In the Soviet Union, the use of inexpensive oil with a low freezing point is considered for use as the coolant. (TTT)

1486 IMPROVED REACTORS. Bede, Gabor. Energia Atomtech., 18: 177-81(Apr. 1965). (In Hungarian).

The Dragon reactor design is discussed. Features are the absence of cladding and an external maximum graphite temperature of 1260°C. The coolant gas is heated from 350 to 750°C and is kept at 20 atm. It is hoped that a temperature of 1600°C will ultimately be reached. The fission products are removed from the coolant by diverting continuously 1% of the gas. The BWR-type reactors were improved by the application of nuclear superheat; the new generation of these reactors includes BONUS, BORAX-5, Pathfinder, and EVESR in the United States and the Marviken BHWR in Sweden. The reactors of the Russian Beloyarsk and Ulya-

novsk power stations generate steam that may be used directly in the turbines of the conventional power plants. The PWR concept was improved in the second core of the Shippingport reactor and by the spectrum-shift design, which involves hardening of the neutron spectrum, and increasing the resonance capture by adding D_2O to the moderator. Novel designs include liquid-fuel and liquid metal cooled reactors; among them the MSRE, fueled with a molten fluoride salt mixture, and the molten-Pu fueled FRTCF. Liquid Na is used to cool the Settled Bed Reactor. The MPRE program is destined for space applications; it also will use liquid metal cooling. All these reactor types are potentially competitive with conventional fuels. (TTT)

1487 NUCLEAR POWER PLANTS BUILT WITH FAST REACTORS. Csom, Gyula. Energia Atomtech., 18: 182-6(Apr. 1965). (In Hungarian).

The effort spent on the development of fast reactors is motivated primarily by their potentially higher fuel economy; they are able to make use of the nonfissionable ^{238}U and ^{232}Th isotopes by transforming them by neutron capture into ^{239}Pu and ^{233}U. The coefficient of reactivity, the void coefficient of Na, and the Doppler effect are considered. A negative temperature coefficient was obtained in most cases. It is postulated that a large-scale fast-reactor construction program will be started by 1975, at which time it is expected that sufficient Pu will become available. The purpose of current fast reactors is to demonstrate the feasibility of safe operation of this reactor type in atomic power plants. Results obtained are satisfactory; the burnup level reached was higher than expected. Future development is aimed at further increase of the burnup, reduction of steel in the core, development of new fuel materials, increase of the core power density in order to improve the thermal efficiency, development of higher-capacity units and application to naval propulsion systems. The burnup may be raised by increasing the internal breeding factor and by developing new types of fuels, able to withstand the high irradiation required by the higher burnup. (TTT)

1488 THE ROLE OF NUCLEAR POWER PLANTS IN COOPERATIVE POWER PLANT SYSTEMS. Ocsai, Mihaly. Energia Atomtech., 18: 201-3(Apr. 1965). (In Hungarian).

It was established that large power-generating units are more economical than smaller ones. Use of large power stations necessitates the formation of coordinated networks in order to use the generated electricity in an efficient manner. Atomic power plants may be included in systems consisting mostly of thermal plants. The high flexibility of atomic power plants was successfully demonstrated by the operating experience of the Shippingport reactor; its power generation rate at times oscillated by as much as 24 Mw/min. Reactors also exhibit a high degree of readiness: the Dresden reactor reached its maximum load from the cold state within 3.5 hours. In the Soviet Union, Siberian coal must be transported great distances; high-capacity long-distance power lines were built; and competitive, large atomic power plants are being developed. By 1970 reactors with a capacity of 1000 Mw and by 1980 with 10,000 Mw will be available. These reactors will originally be thermal-neutron plants but later fast reactors will be also built. Calculations in the United States in 1959 indicated that by 1970 the cost of the generated power will be 7 mills/kw hr; this figure has been revised downward to 4 to 5 mills/kw hr. The increasing size of the plants in England resulted in the reduction of the specific power cost. The British network is based primarily on thermal plants and operates at a use factor of only 47%; future plans include atomic power plants as the mainstay of the system. The French system, based on gas-cooled, graphite-moderated reactors, attempts to approach systematically the optimum economic conditions. The currently available and planned atomic plants do not affect the network. (TTT)

1489 A CRITICAL SURVEY OF THE CIRENE PROJECT. Silvestri, M. (Laboratori CISE, Milan). Energia Nucl. (Milan), 12: 509-14(Oct. 1965). (In Italian).

The research and development program on a nuclear reactor, cooled by a steam-water mixture, heavy-water-moderated, natural-uranium-fueled, called CIRENE (CIse REattore a NEbbia), is described. The CIRENE program will be concluded at the end of 1967 and aims at supplying all the data and elements needed for the eventual construction of a prototype power reactor. (auth)

1490 THE NOK NUCLEAR POWER STATION. Euro Nuclear, 2: 430-3(Sept. 1965).

The NOK power plant, which is to be built at Beznau, is briefly described including the pressurized light-water reactor, the primary plant, the secondary plant, and the double containment system. (D.C.W.)

1491 NUCLEAR POWER DEVELOPMENTS IN YUGOSLAVIA. Suica, S. Euro Nuclear 2: 434-6(Sept. 1965).

An analysis of the long-term power requirements and resources of Yugoslavia is summarized. It is concluded that after 1975 the construction of nuclear power stations in Yugoslavia will be justified. (D.C.W.)

1492 UTILIZATION OF SHUT-DOWN ENERGY OF THE TURBOGENERATOR FOR EMERGENCY SUPPLY IN THE CASE OF AN ACCIDENT. Rosenkranz, H. (VEB Atomkraftwerk, Berlin). Kernenergie, 8: 410-13(July 1965). (In German).

The case of accident total breakdown of voltage causes the shut-down of the primary cooling system circulating pumps and, consequently, danger in the reactor core cooling system in pressurized water nuclear power stations. Utilization of the shut-down energy of the turbogenerator for the supply of the circulating pumps is shown to improve essentially the conditions of emergency cooling of the reactor core. (auth)

1493 GRAPHITE-MODERATED WATER-COOLED PRESSURE-TUBE REACTORS. Wenzel, P. (VEB Atomkraftwerk, Berlin). Kernenergie, 8: 449-65(Aug. 1965). (In German).

Information is included on: development of the graphite-moderated steam-cooled pressure-tube reactors and similar types; first atomic power station Obninsk–pilot plant for the development of graphite-moderated steam-cooled pressure-tube reactors; nuclear power station Beloyarsk–first and second stage of equipment; 1000 Mw(e) project using supercritical coolant parameters; evaluation of the graphite-moderated steam-cooled pressure-tube reactor. 41 references are cited. (auth)

1494 ON THE DEVELOPMENT OF NUCLEAR POWER. Dubrau, H.-J. Kernenergie, 8: 465-7(Aug. 1965). (In German).

Classification of nuclear power within the general system of power generation is proposed. Its importance in the next 30 years is evaluated. (auth)

1495 INVESTIGATION OF THE EMERGENCY DYNAMIC BEHAVIOR OF PRESSURIZED-WATER NUCLEAR POWER STATIONS. Rosenkranz, H. (VEB Atomkraftwerk, Berlin). Kernenergie, 8: 471-7(Aug. 1965). (In German).

An investigation was made on the behavior of a pressurized-water nuclear power station when the power supply of the primary coolant circulation pump fails, or in the case of the turbo-generator emergency shut-down. Adequate measures are proposed to limit the transient processes in a given permissible manner after occurrence of the accident. The study was carried out by using an analog computer. (auth)

1496 ENGINEERING PROBLEMS OF POWER REACTOR FUEL. I. CALDER HALL TYPE FUEL IN TOKAI POWER STATION. Imai, Ryukichi (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi, 7: 499-505 (Sept. 1965). (In Japanese).

The fabrication of power reactor fuel in Japan is discussed. Experience in the fabrication of Tokai fuel is described. The mode of swelling of tubular fuel, creep collapse of U under coolant pressure, and end welding of the tube were three problems. Deformation of heat trans-

fer surfaces, post irradiation examination, inspection experiences at the Springfields Works, and interpretation of the specifications are also discussed. (auth)

1497 GRAPHITE FOR THE COMMERCIAL AGR. Hutcheon, J. M. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); Prince, K. Nucl. Eng., 10: 368-70(Oct. 1965).

In maintaining the advantages of gas-cooled reactors, while reducing capital and fuel costs, the AGR uses major increases in power core density, and gas temperature and pressure. The first increases both the neutron damage to graphite and the radiolytic oxidation rate. The implications of increased neutron damage lie mainly in the consequence of dimensional changes, such as distortion of columns of bricks and strains induced within individual graphite components. There is also an increase in the rate of heat generation within the graphite resulting in higher graphite temperatures. Control of radiolytic oxidation is required to avoid reductions in moderator efficiency and serious loss of strength in graphite components. Such problems are considered. Topics discussed include dimensional changes, core stability and alignment, differential shrinkage strains, loss of graphite, coolant additives, mechanism of methane effect, and loss of strength. Other topics are evaluation of strength losses, coolant composition control, and future development. (J.F.P.)

1498 CORE PERFORMANCE FOR THE AGR. Cutts, B. (United Kingdom Atomic Energy Authority, Risley, Eng.); Tyror, J. G. Nucl. Eng., 10: 371-3(Oct. 1965).

The overall physics performance of an advanced gas-cooled reactor is calculated by assuming some form of separation between events in a channel and those in the rest of the reactor. Thus reaction rates are evaluated for individual lattice cells of fuel, vacant channel, absorber, etc., in the lattice calculation assuming an idealized environment; and the results are condensed to enable the interaction between the cells to be studied in the reactor calculation. Lattice, reactor, and fine structure calculations are considered. Nuclear design performance of the Dungeness B Reactor is also discussed. Enrichment requirements of fuel, power variation due to burnup, fuel-cycle management, fuel rating history, stability and kinetics, fault studies, and future developments are discussed. (J.F.P.)

1499 THE AGR FUEL. Greenough, G. B. (United Kingdom Atomic Energy Authority, Springfields, Eng.); Nairn, J. S.; Waine, P. Nucl. Eng., 10: 373-4(Oct. 1965).

The design of fuel for the Dungeness B power station comprises a cluster of 36 pins, 0.57 in. dia and approximately 40 in. long. This fuel element together with a near optimum fuel-to-moderator ratio, permits alignment in the head of the prestressed concrete vessel that can be constructed satisfactorily while retaining the advantages of single-channel access. The average rating of the first commercial advanced gas-cooled reactor cores will be about 9.5 Mw(t)/t and the design, using fuel management, will have a peak rating of about 23 Mw(t)/t for fuel and graphite. The temperature limits specified are well within the demonstrated capabilities of the stainless-steel canning material and the currently manufactured UO_2. The behavior of the pin cladding and oxidation behavior are also discussed. (J.F.P.)

1500 DEVELOPMENT OF THE DUNGENESS B DESIGN. Warner, P. C. Nucl. Eng., 10: 375-8(Oct. 1965).

It is shown how the design of the Dungeness B evolved over the 18 months before tender date. The essential features of the advanced gas-cooled reactor system already developed and in the process of development formed the basis of the concepts; but alternative designs and independent opinions were also considered regarding the most suitable and the cheapest layout. Only the major features affecting the reactor itself are discussed. Channel and core arrangement, channel access and fuel handling, the hot box (which contains the hot gases at outlet from the fuel channels and transfers them to the inlet of the boiler without allowing them to impinge on the walls of the steel pressure vessels and ducts), channel gags, and late modifications are considered. (J.F.P.)

1501 THE DUNGENESS B APPRAISAL. Imai, Ryukichi. Nucl. Eng., 10: 379-80(Oct. 1965).

In the Dungeness B reactor appraisal by United Kingdom experts it is assumed that it is a genuine assessment, without other motives, and that the choice made for this reactor is the United Kingdom's choice for the coming very large nuclear power program. It is pointed out that the result of power reactor evaluation depends upon the boundary conditions initially set, and is therefore very specific to the case examined. It is concluded that the appraisal represents a valuable exercise and may have far-reaching effects. The policy decisions preceding the appraisal, and other factors affecting the conclusion are considered. (J.F.P.)

1502 BIG FUTURE FOR THE AGR. Greenhalgh, G. H. Nucl. Eng., 10: 381-2(Oct. 1965).

Information on the comparative cost of the advanced gas-cooled reactors, boiling water reactors, and coal-fed stations shows that nuclear power in Great Britain is for the first time clearly cheaper than any other source of power. Since the first of the Calder Hall reactors have been operating for nearly nine years at high load factors without showing any detectable harmful effects on the graphite moderator or the structure of the plant, there is confidence that these stations will exceed their design life of 30 years. It can be shown that the generating costs of the later magnox stations are roughly the same as those for coal or oil-burning stations. The change from natural uranium to an enriched oxide is discussed. The size of the program for nuclear power generation is discussed, and the effect on conventional plants, and the chance for smaller reactors are considered. (J.F.P.)

1503 DFR AS AN IRRADIATION FACILITY. Edwards, A. G. (United Kingdom Atomic Energy Authority, Dounreay, Eng.). Nucl. Eng., 10: 383-7(Oct. 1965).

More than 80 separate rigs are mounted in the Dounreay Fast Reactor so that this reactor may claim to be operating as a general irradiation facility, data about the irradiation characteristics of its own charge being only a small part of the information it generates. The Dounreay Fast Reactor has advantages as an irradiation facility and some disadvantages, of these the principal one is the difficulty of instrumenting rigs and of extracting temperature information. The basic advantages of irradiating under the conditions of intense fast flux are considered for different types of specimens. A brief description of the reactor follows together with some account of its limitations and how they may be minimized or overcome. Types of irradiation testing including survey testing with small fuel specimens, testing of isolated pins, subassemblies, graphite, other tests, and cladding materials are also given. (J.F.P.)

1504 SOME ENGINEERING CONSIDERATIONS. Vaughan, R. D. Nucl. Eng., 10: 389-91(Oct. 1965).

An account is given of the more noteworthy problems arising during the construction of the Dungeness A. These unanticipated problems encountered in such a project are those which stem from the extension of the operating parameters beyond previous experience and those in the detailed design of certain components when they are required to do more than was originally intended. Topics discussed include reactor pressure vessels, circulating water tunnels, self-lock seals and standpipe assemblies, gas circuit vibration, core structure tank, actuators and secondary shutdown rods, and charge machinery. (J.F.P.)

1505 COMMISSIONING. Gabriel, E. Nucl. Eng., 10: 392-4(Oct. 1965).

Commissioning procedures in the nuclear power stations are well established and known, and those at Dungeness conform to these procedures in general. But significant changes were made either under the constraint of the design or as developed from the experience and careful study

of the techniques adopted in the commissioning. These changes are described and the present state of commissioning techniques discussed. The experience at Dungeness indicates a change in the relation between construction and commissioning times. Possible future developments following upon these changes are suggested. The design aspects, construction completion and combined testing, pre-start-up operations, initial fuel loading, physics measurements, core channel flow measurements, and gag setting are discussed. (J.F.P.)

1506 DUNGENESS—FROM A TO B. Shaw, A. L. (Nuclear Power Group, Knutsford, Eng.). Nucl. Eng., 10: 395-400(Oct. 1965).

The Dungeness A occupies an interesting place in the British nuclear power program. It is the first second-round station. The design of this reactor was an extrapolation of earlier design and construction experience. With the Dungeness design, development of the magnox system based on thick steel pressure vessels had reached its practical limits. Within the limit of top temperature imposed by magnox canning, the considerable strides taken in the reduction of both capital and generation costs were accomplished by engineering advances, chiefly affecting reactor coolant gas pressure. Through its important effects on heat transfer and blower power, heat extraction per ton of fuel and overall thermal efficiency were greatly improved. When these possibilities were fully exploited, the design of the Dungness B advanced gas-cooled reactor gave the necessary step change. With only a relatively small increase in gas pressure from Wylfa but an increase in bulk outlet gas temperature, the mean fuel rating has multiplied 11.3 times from Calder and four times from Wylfa. (J.F.P.)

1507 ELECTRIC POWER SYSTEMS OF FOREIGN NUCLEAR POWER PLANTS. Vincens, E. Nucl. Safety, 5: No. 3, 240-9(Spring 1964).

A review and evaluation of the electric power system of nuclear power plants outside of the U. S. is presented. Information is included on Douglas Point Power Station (Canada), Nuclear Power Demonstration Station (Canada), Ardennes Nuclear Power Station (France-Belgium), Chinon Nuclear Power Station (France), Jülich Nuclear Power Station (Germany) Kahl Nuclear Power Station (Germany), Gundremmingen Nuclear Power Station (Germany), Garigliano Nuclear Power Station (Italy), Latina Nuclear Power Station (Italy), Simpevarp Nuclear Power Station (Sweden), Calder Hall B Nuclear Power Station (U. K.), Windscale Advanced Gas Cooled Reactor (U. K.), and Takai Nuclear Power Station (Japan). (J.R.D.)

1508 OPERATING EXPERIENCE AT SAXTON. Howard, D. E. Nucl. Safety, 5: No. 3, 269-77(Spring 1964).

The Saxton plant is described and information is presented on plant operation, operator training and licensing, reactor scrams, radiation levels and shielding, and waste disposal. (J.R.D.)

1509 ACTION ON REACTOR PROJECTS UNDERGOING REGULATORY REVIEW. Buchanan, J. R. Nucl. Safety, 5: No. 3, 277-83(Spring 1964).

The license-application records of U. S. power reactors is presented tabularly. Recent regulatory actions and items of current interest relative to specific reactors are described. (J.R.D.)

1510 CHANGES IN LICENSING REGULATIONS. Buchanan, J. R. Nucl, Safety, 5: No. 3, 283-4(Spring 1964).

Discussions are presented concerning changes being considered for Part 2, rules of practice; Part 20, standards for protection against radiation; Part 30, licensing of by-product material; Part 70, special nuclear material; Part 115, procedures for review of certain reactors exempted from licensing requirements; and Part 150, exemptions and continued regulatory authority in agreement states under section 274. (J.R.D.)

1511 DESIGN CRITERIA FOR THE NPR REACTOR BUILDING. Davis, Harold S. (General Electric Co., Richland, Wash.). Nucl. Struct. Eng., 2: 203-10(1965).

The 105-N building, which houses the world's largest power reactor, is a highly specialized structure of reinforced concrete and steel. The secondary shielding walls, which surround the reactor and its coolant system, are 4 to 5.5 feet thick; the ceilings 1.5 to 2.5 feet thick. These walls are designed to reduce radiation levels to safe human tolerance during normal reactor operation and to function as a low pressure confiner during an emergency. Interior surfaces are covered with an elastomeric coating consisting of 15 mils of neoprene and 5 mils of (white) hypalon. In addition to normal dead and live loads, the structure is designed to resist: a temperature differential of 40°F, an internal pressure of 5 psig or a vacuum of 2 psig, and seismic loads associated with a ground acceleration of 0.2 gravity. Criteria used in the detail design of the 105-N building are reproduced. (auth)

1512 DESIGN OF BONUS CONTAINMENT STRUCTURE. Siler, W. C.; Wells, J. H. (United Engineers and Constructors, Boston). Nucl. Struct. Eng., 2: 306-14 (1965).

This description of the design of the (BONUS) containment structure places emphasis on the design of the reinforced concrete foundation slab, since design of an unsymmetrically loaded mat on an elastic foundation is one of the more complex problems in structural engineering. A brief description of the steel shell superstructure is also included for completeness. (auth)

1513 POWER REACTOR TECHNOLOGY. Volume 8, Number 3. Zinn, Walter H.; Dietrich, J. R. (Combustion Engineering, Inc., Dunedin, Fla. Nuclear Div.). Summer 1965. Contract AT(30-1)-2379. 44p. GPO $0.70(domestic), $0.90(foreign).

One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC.

Reviews are presented concerning recent developments in physics, fluid and thermal technology, fuel elements, components, sodium-graphite reactors, and unconventional reactors. Abstracts were prepared for each of the reviews. (J.R.D.)

For abstracts of individual sections see: 486, 907, 1356, 1367, 1514, and 1515.

1514 SPECIFIC REACTOR TYPES. Power Reactor Technol., 8: No. 3, 183-5(Summer 1965).

Results are presented of a steam-cycle study on sodium-graphite power plants to determine optimum steam conditions and sodium system parameters for 350 to 400-Mw(e) plants. (J.R.D.)

1515 UNCONVENTIONAL APPROACHES. Power Reactor Technol., 8: No. 3, 186-98(Summer 1965).

Design and economic evaluation of the Fast Supercritical-pressure Power Reactor are reviewed. Results of a design and evaluation study on a graphite superheat reactor are also reviewed. Data are summarized for 300- and 1000-Mw(e) superheat plants. The IBM-7090 program FLEX-II was used in most physics analyses. (J.R.D.)

1516 COMPARISONS OF POWER CONVERSION SYSTEMS FOR LUNAR NUCLEAR POWER PLANTS. Pouchot, W. D.; Severson, W. J.; Roberts, D. R. (Westinghouse Electric Corp., Pittsburgh). 17p. (CONF-650602-66). Gmelin, AED-CONF-65-125-38.

From American Nuclear Society, 11th Annual Meeting, Gatlinburg, Tenn.

An attempt was made to define the nuclear power plant concept which would best supply modular blocks of power to an expanding lunar base complex. Some of the important constraints on the power plant study were those imposed by the reference launch vehicle, logistic considerations, and lunar environmental conditions. A comparison of thermoelectric Brayton and Rankine cycle power conversion systems outputs, as constrained by a 25,000 pound overall plant weight limitation of a Saturn V payload revealed that present day thermoelectric system efficiencies are too low to produce 100 kw electrical output, the Brayton cycle con-

version systems can just reach 100 kw(e), and the mercury or potassium Rankine cycle systems can exceed the 100 kw(e) level. (J.F.P.)

1517 IMPROVEMENTS IN AND RELATING TO STEAM GENERATORS. Jones, Francis Robert (to Foster Wheeler Ltd.). British Patent 1,002,861. Sept. 2, 1965. Filed July 19, 1963.

A steam generator is described for use with a nuclear reactor in which the heating fluid is the primary fluid that has been used for cooling the reactor and that is at a pressure of about 1500 to 2500 psig. The generator is described with particular application to a steam–water system but is applicable to use with other suitable liquid–vapor systems. The generator has an upright cylindrical shell containing a vertical bundle of tubes for circulation of the heating fluid. The tubes are connected at their ends to heating fluid inlet and outlet headers passing through the shell. The tube bundle generates from water fed to the lower end of the shell through a coaxial downcomer a steam–water mixture that rises toward a steam outlet at the upper end of the shell. Each tube of the vertical bundle is of composite construction and comprises an inlet tube and an outlet tube joined by a cluster of straight tubes of small diameter having at each end a circular or polygonal manifold. The clusters are distributed over the cross section of the shell so as to form an annular bank closely surrounding the downcomer and occupying the greater part of the cross-sectional area of the shell. (B.L.M.)

1518 CURRENT GENERATING PLANT OPERATING WITH GAS-COOLED REACTOR. Folgmann, August (to Siemens-Schuckertwerke A.G.). German Patent 1,192,659. May 13, 1965. Filed June 22, 1963.

The power plant includes a gas-cooled nuclear reactor and a compressor arranged to effect circulation of gaseous coolant in a closed circuit through the nuclear reactor and through the heat exchange means in which steam is generated and superheated. The steam flows from the vapor generator to a turbine driving the gas compressor and from there to a steam turbine driving the electric generator. While the compressor turbine is operated at constant pressure the pressure of the turbine driving the electric generator is varied. The electric power generated is controlled by changing the speed of the gas circulation in the primary circuit. (Gmelin Inst.)

1519 NUCLEAR SUPERHEATER REACTOR. Strehober, Wilherm (to VEB Atomkraftwerk Rheinsberg mit Betriebsteil Berlin). German Patent 1,195,880. July 1, 1965. Filed Apr. 13, 1960.

The nuclear superheater reactor comprises a core of vertically arranged hollow fuel cylinders which are surrounded by the boiling fluid and through which the steam generated on the outside flows downward. The core is laterally surrounded by a vertical, cylindrical partition wall. The upper and lower end of the annular space between the partition wall and the reactor vessel is closed by two horizontal partition walls. The water inlet is located in the upper portion of the annular space which communicates with the core portion of the reactor vessel through radially directed openings in the lower portion of the vertical partition wall. (Gmelin Inst.)

1520 DEVICE FOR PREVENTION OF AN EXCESSIVE PRESSURE ORIGINATING IN THE PRIMARY CIRCUIT OF A TWO-CIRCUIT NUCLEAR POWER PLANT BY MEANS OF A TUBE RUPTURE WITHIN THE HEAT EXCHANGER. Merli, Elio (to Comitato Nazionale per l'Energia Nucleare). German Patent 1,199,895. Sept. 2, 1965. Priority date Feb. 6, 1963, Italy.

The nuclear power plant comprises a closed primary circuit through which an organic fluid is circulated and which communicates with an expansion tank. A piping provided with a valve connects the primary circuit to a draining tank. The secondary circuit containing water is operated at a higher pressure than the primary circuit and is provided with an expansion valve through which water may be let off into the air. Both valves are simultaneously opened by the signal of a pressure indicator located in the primary circuit at a predetermined value of pressure. (Gmelin Inst.)

1521 APPARATUS FOR PRODUCING HEAT AND POWER BY THE APPLICATION OF NUCLEAR FISSION. Barr, Frank T.; Cohen, Karl (to Esso Research and Engineering Co.). U. S. Patent 3,205,138. Sept. 7, 1965. Filed Feb. 28, 1961.

A reactor for generating nuclear power includes an outer protective shield and an inner matrix. The inner matrix of cellular cross section is made up of a series of stacked, self-supporting sheets of beryllium or beryllium oxide. Each sheet has regular flat-sided corrugations with adjacent sheets forming a laminate by surfaces of successive flat sides contacting each other in a generally horizontal plane. Fissionable material is distributed throughout the inner matrix. An outer matrix similar in construction to the inner one surrounds the inner matrix and defines a plurality of horizontal passages for the circulation of coolant. Header means are provided at each end of the passages for containing and circulating the coolant. (B.L.M.)

1522 BOILING WATER NUCLEAR REACTOR PRODUCING SUPERHEATED STEAM. Kluge, Hans; Fischer, Erhard (to Licentia Patent-Verwaltungs-G.m.b.H.). U. S. Patent 3,206,372. Sept. 14, 1965. Priority date Feb. 12, 1960, Germany.

A boiling water reactor for producing superheated steam includes both an inner and outer pressure vessel. A plate intermediate the top and bottom of the outer vessel and a dome mounted on the plate constitute the inner pressure vessel. The tubular fuel elements connect with the plate and communicate through the plate with the inner pressure vessel. The fuel rods disposed in the tubular elements substantially restrict the space within the elements for fluid flow and maintain the water level in the outer vessel above the top of the inner vessel but below the top of the outer vessel so that the water will flow upwardly through the elements towards the inner pressure vessel. The flow restriction is such that the water flowing upwards is converted into steam before it reaches the upper ends of the elements and is superheated by the time it emerges from the upper end of the elements into the inner pressure vessel. The superheated steam is drawn from the inner chamber for operation of a turbine of the like. (B.L.M.)

1523 THREE TANK SEPARATE SUPERHEAT REACTOR. Pennington, Robert T. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,986. Oct. 19, 1965.

A liquid moderated nuclear reactor is described for superheating steam. The reactor comprises an outer pressure vessel having a removable cover, a first inner tank concentric with the outer pressure vessel and spaced apart therefrom with liquid moderator material flowing therebetween, a second inner tank containing fissile fuel rods interspersed between a plurality of process tubes arranged in geometric ordered array, the second inner tank being concentric with the first inner tank and spaced apart therefrom for incoming steam to pass therebetween for superheating and control rods in each of the process tubes arranged so that the liquid moderator flows therethrough. (AEC)

1524 NEUTRONIC REACTOR WITH INTERLOCKING DIFFUSER END GRID. Mason, A. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,987. Oct. 19, 1965.

A mobile ceramic nuclear reactor structure made up of hexagonal bricks of moderator, fuel, and reflector, enclosed in a pressure shell, each brick being provided with one or more axial passageways to permit axial coolant flow is discussed. Hollow bricks with internal, curved baffles form the ends of each axial channel to limit neutron streaming. Overhanging diffuser lips on the outboard bricks interlock with the end faces of the adjacent bricks to keep the bricks aligned even during accelerations. (AEC)

Process Heat Reactors

1525 SUSPENSION FOR THE HEAT EXCHANGER UNITS OF A NUCLEAR REACTOR CONNECTED TO A WASTE-HEAT STEAM GENERATOR. Huet, Andre. German Patent 1,193,962. June 3, 1965. Priority date Jan. 15, 1957, France.

The vapor generating plant comprises a plurality of rows of vertically arranged containers connected in parallel to each other whereby each row has common inlet and outlet headers. The containers are suspended from supporting beams provided with consoles by means of studs attached to the upper part of the containers. In order to prevent high temperature differences between the lower and upper ends of the containers each container contains only a single or two heat exchange elements like pre-heater, evaporator, or superheater elements. Containers including like heat exchange elements are arranged in a row. (Gmelin Inst.)

1526 HETEROGENEOUS, THERMAL NUCLEAR REACTORS, ESPECIALLY BOILING-WATER REACTORS, FOR THE INSERTION INTO BITUMINOUS DEPOSITS REACHED BY BORE HOLES. Schicht, Guenter; Lange, Hans (to Deutsche Erdoel-Aktiengesellschaft). German Patent 1,198,943. Aug. 19, 1965. Filed Aug. 8, 1961.

The reactor has a reflector outside the reactor vessel comprising two extension shells constructed in the shape of a basket and internally covered with high-temperature resistant, elastic skin. These shells consist of a plurality of overlapping, lamellar iron sheets which are arranged in such a way that as soon as the lower end of the basket touches the bottom of the drilled hole the basket unfolds like a balloon into which the light water is filled for reflecting purposes. (Gmelin Inst.)

Propulsion and Space

See also ENGINEERING — Space Propulsion

Refer also to abstract 1438.

1527 (NAA-SR-9778) SNAP 10A, EXPANSION COMPENSATOR. Sudar, S. (ed.) (Atomics International, Canoga Park, Calif.). Oct. 1, 1965. Contract AT-11-1-GEN-8. 72p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

The SNAP 10 A Nuclear Power Unit (NPU) utilizes two expansion compensator units (ECU) to absorb the volumetric increase of NaK due to thermal expansion, to provide a void-free NaK system, and to regulate the NaK system pressure. In order to fulfill these system operation requirements, an ECU was developed which utilizes a welded bellows fabricated from AM-350 (SCT-850) precipitation hardening steel foil. For increased reliability, the ECU has a secondary NaK containment housing which permits continued system operation at design power in the event of a bellows failure. An extensive development test program was conducted on separate bellows capsules and ECU's to evaluate fatigue life, pressure capability, and endurance performance in a high temperature-liquid metal (NaK-78) environment. The parameters affecting welded bellows quality—the material cleaning, welding and heat treating—were thoroughly investigated. Extensive statistical regression and correlation studies were performed to establish a suitable weld bead width versus penetration ratio and the size control limits of the bellows welding process. (auth)

1528 (NAA-SR-11207) MAGNETIC MOMENTS AND VEHICLE TORQUES IN THE SNAP 10A. Boyle, T. J.; Galantine, R. M. (Atomics International, Canoga Park, Calif.). Oct. 1, 1965. Contract AT-11-1-GEN-8. 50p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Small magnetic dipole moments arise in the SNAP 10A nuclear electric power system due principally to the permanent magnet in the electromagnetic pump and current flowing in the thermo-electric converter. The dipole moments interact with the earth's magnetic field to produce torques on the orbiting vehicle. The nature of these torques, the procedures which were used to evaluate them, and methods for reducing them are discussed. (auth)

1529 (NAA-SR-Memo-10961) THERMAL MODEL FOR USE IN SNAP SYSTEM SIMULATION. Winson, R. W. (Atomics International, Canoga Park, Calif.). Mar. 2, 1965. Contract AT-11-1-GEN-8. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A thermal model, in transfer function form, was developed to describe the heat transfer within either a fluid to fluid or fluid to solid heat exchanger. The model is primarily intended for use as a four terminal network for use in the simulation of complex systems such as a SNAP reactor and its primary loop. In the form presented, it is an accurate thermal representation of the exchanger using a minimum mathematical representation. The model can also be used, in model form, to accurately determine the time dependent temperature distribution within the heat exchanger. An approximation of the model is also presented which in many cases simplifies the simulation of the equations on analog equipment. Two digital subroutines used in simulating the thermal model and its approximation on a digital computer is presented. (auth)

1530 WHAT HAPPENED TO SNAP 10A? Wilson, R. F.; Dieckamp, H. M. Astronaut. Aeronaut., 3: 60-5 (Oct. 1965).

The performance of the SNAP-10A system launched on April 3, 1965, is discussed with emphasis on its unexplained shutdown after 43 days of successful operation. The available data indicate that the system did not fail, but rather responded in a normal manner to spurious signals from failed electronic components on the spacecraft. Some improvements that can increase the performance of such systems are considered. (D.C.W.)

1531 THE CRITICAL MASS OF CAVITY REACTORS WITH GASEOUS FISSIONABLE MASS FOR ROCKET ENGINES. Tumm, Guenter W. (Columbia Univ., New York). Raumfahrtforschung, 9: 105-11(July-Sept. 1965). (In German).

The known nuclear physical problems in connection with the critical mass of the cavity reactor with gaseous fissionable substance are summarized with special consideration of the application to rocket engines. Some general conclusions are derived from the theoretical and experimental results. Special emphasis is given to the question of minimal critical mass considering the effects of interior and exterior fuel compression and fuel temperature. It is shown that the vortex flow-type requires a smaller critical mass than the coaxial flow-type under comparable conditions. (auth)

1532 GASEOUS NUCLEAR ROCKET. Rom, Frank E. (to National Aeronautics and Space Administration). U. S. Patent 3,202,582. Aug. 24, 1965. Filed Aug. 28, 1961.

Design of a gaseous nuclear rocket engine is described that has an extremely high working fluid operating temperature, that has a thermal radiation absorption blanket around the fissioning uranium gas, and that has a higher specific impulse than that obtainable with solid fuel element nuclear reactors. One or more streams of a working fluid are introduced concentrically adjacent to a gaseous fissile material in a heating chamber or cell. Introduction of the fluid in this manner permits transfer of heat by radiation from the fissioning gaseous material and reduces the mixing of the working fluid with the gaseous fissioning stream to a minimum, thus increasing the residence time of the fissile material relative to the working fluid to conserve fuel. The proposed rocket propulsion system provides for increasing payload weights while maintaining a constant gross weight. (B.L.M.)

Research and Test Reactors

Refer also to abstract 1458.

1533 (CONF-650532-2) QUALITY EVALUATION OF CP-5 REACTOR FUEL. Beyer, Norman S. (Ar-

gonne National Lab., Ill.). 1965. Contract W-31-109-eng-38. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn. From Institute of Nuclear Materials Management Meeting, Cincinnati.

The manner in which verification of the quality of the fuel for the CP-5 reactor was carried out is described. Three nondestructive inspection techniques were used for this examination. They were radiographic, ultrasonic, and gamma scintillation spectrometric. The three techniques each have unique features which are described together with a general description of how the methods were used to provide an evaluation of the fuel. (M.O.W.)

1534 (LA-3370) QUARTERLY STATUS REPORT ON ADVANCED REACTOR TECHNOLOGY (ART) FOR PERIOD ENDING JULY 31, 1965. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Aug. 1965. Contract W-7405-eng-36. 61p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

Progress on construction of the Fast Reactor Core Test Facility is reported. Descriptions are included concerning construction of the building and associated services, installation of a 20-Mw Na coolant system, installation of a control room, and construction of the reactor. Information is also included on design of a molten Pu burnup experiment and fuel testing in the Omega West Reactor. Data are included from accelerated fuel corrosion tésts, mass transfer of Ta in molten fuel alloys, and preparation of UCl_3–KCl–NaCl for blanket studies. Efforts devoted to research on Na purity, venting fission gases in Na coolant, and Na-fuel equilibria are discussed. Research is summarized on properties of Pu carbides, U_2C_3–Pu_2C_3 systems, Pu nitrides, and Pu–Sc alloys. Progress on construction and component testing in the UHTREX program is summarized, along with research on plasma thermocouples and heat pipes. (J.R.D.)

1535 PREPARATION OF PLATE FUEL ELEMENTS FOR RESEARCH REACTORS. Ennerest, K.; Eschnauer, H. Atoomenergie Haar Toepassingen, 7: 113-21(June 1965). (In Dutch).

A description is given of the fabrication of fuel elements for the Netherlands Research Reactors. The guarantee given by the fabricator of the fuel elements was discussed. (tr-auth)

1536 AUTOMATIC CONTROL OF THE REACTOR OSIRIS AT SACLAY. Automatisme, 10: No. 1, X(Jan. 1965).

Centralized processing of measurements and instrument readings of the reactor "Osiris", now being built at Saclay, will be achieved. This high neutron flux reactor will consist of a large enriched uranium swimming pool reactor, whose thermal output will reach 500 Mw. In its experimental channels, Osiris will enable the behavior of various materials and fuel samples and the production of artificial radionuclides to be studied. The data processing system set up is described. The various useful magnitudes will be detected simultaneously, both in the experimental channels and the reactor itself. This data will be centralized and processed to fulfil monitoring and warning functions as well as to analyze the measurements. The various results will be edited onto punched tape and in the form of printed tables offering the research teams broader possibilities of deferred analysis while at the same time enabling the essential results to be exploited immediately. (French Technical Press, No. 1, 1965)

1537 RESEARCH REACTORS. Varkonyi, Lajos; Pallagi, Dezso. Energia Atomtech., 18: 204-8(Apr. 1965). (In Hungarian).

Papers on the experience gained with research reactors and with their design improvements, presented at the Third Geneva Conference, are summarized. In the Soviet Union, several reactors with a flux of $> 10^{15}$ n/cm^2 sec were built for research purposes. The most important research reactors include: the SM-2 with a capacity of 55 Mw, with an E > 1 Mev flux of 10^{15} n/cm^2 sec; the MPR and MR swimming-pool reactors; the PGR pulsed reactor with a maximum pulse of 1×10^{18} n/cm^2 sec; and the PFR pulsed fast reactor. The IRT and VVR-S type reactors were further improved. In the United States, two new reactor types were constructed: the HFBR at Brookhaven and the HFIR at ORNL. The AARR at Argonne is scheduled to start operation in 1969. The Triga type was also further improved. Most of the older research reactors at the national laboratories are still in operation; in addition, the number of university reactors continues to grow. The French are now in position to design research reactors using enriched U fuel; their new reactors include Melusine, Triton, Siloé, and Pégase; Osiris is scheduled to go critical in 1966. The British papers described experience with the Dido-type reactors. The zero-power Daphne reactor at Harwell serves as prototype for the high-flux systems; the Herald type is widely used for solid-state and nuclear physics research. The Canadian, Czech, Polish, and West German studies are also summarized. In Japan, 8 reactors were built since 1955 and 3 additional ones are under construction; they are used mostly for studying power generation problems. Mention is also made of the research reactors built in Spain, Brazil, Holland, Portugal, India, Turkey, and Taiwan. (TTT)

1538 RADIOLOGICAL PROTECTION IN THE JEN-1 REACTOR. Orcoyen, S. Garcia. Energia Nucl. (Madrid), 9: 58-67(1965). (In Spanish).

The area monitoring equipment in use at the JEN-1 reactor for the control of the ambient radiation is described. (J.S.R.)

1539 INDEPENDENCE FROM THE BURNUP OF THE AMOUNT OF DELAYED NEUTRON PRECURSORS IN RECOMBINER OF L54M REACTOR. Lazzarini, E.; Sangiust, V.; Terrani, M. (CESNEF, Milan). Energia Nucl. (Milan), 12: 524-5(Oct. 1965).

The effect of the burnup on the transfer of delayed neutron precursors from the core to the recombiner of L54M reactor was investigated while the burnup grew for a factor 3.1. The data obtained excluded any correlation between the burnup and the amount of the delayed neutron precursors transferred from core to the recombiner. From this result it was deduced that the ratio of the amounts of elementary iodine to those of all other iodine compounds present in the fuel is independent of the burnup. (auth)

1540 RESEARCH CENTRES IN EUROPE. NO. 9—STUDSVIK (SWEDISH RESEARCH ESTABLISHMENT). Euro Nuclear 2: 447-54(Sept. 1965).

The organization of the Studsvik research center is summarized, and the experimental facilities and programs of the center are outlined. (D.C.W.)

1541 DETERMINATION OF CORROSION PRODUCTS IN THE FUEL SOLUTION OF THE BER-REACTOR. Ehn, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 7: 383-7(Aug.-Sept. 1965). (In German).

Equipment for taking samples from the BER and a shielded box for remote solvent extraction operations are described. Extracted iron, nickel, and chromium complexes were determined in an unshielded spectrophotometer. The nickel benzildioxime complex in xylene had a molar extinction coefficient of 11.0×10^3 cm^2/mole at 410 nm. Iron was extracted with methyl isobutyl ketone and then brought back in aqueous solution and determined there as the Fe(II)-1,10 phenantrolincomplex (11.2×10^3 cm^2/mole at 510 nm). Chromium was determined as the chromium diphenylcarbazide complex in methyl isobutyl ketone (4×10^4 cm^2/mole at 540 nm). From the results of Fe, Cr, and Ni determinations in the fuel solution and assuming homogeneous corrosion it was calculated that a 6×10^{-3} mm thick layer was removed from the fuel container after 3 years of reactor operation. (auth)

1542 ARGONNE TRANSIENT REACTOR TEST FACILITY. Pitkanen, P. H. Nucl. Safety, 5: No. 3, 234-8 (Spring 1964).

Test facility metal-water reaction experiments and fuel-element meltdown studies in the fast-reactor safety program are reviewed. Information is included on General

Electric fuel-element tests, EBR-II type fuel-element tests, Enrico Fermi type fuel-element tests, oxidation studies, and theoretical studies. (J.R.D.)

1543 REACTIVITY MEASUREMENTS IN HECTOR. Kinchin, G. H. (Atomic Energy Establishment, Winfrith, Eng.). 3p. (CONF-650602-65). Gmelin, AED-CONF-64-219-134.

From American Nuclear Society, 11th Annual Meeting, Gatlinburg, Tenn.

HECTOR is a graphite-moderated zero-energy reactor with an annular driver region that is maintained at a temperature below 60°C and a central region that can be heated to a temperature of 450°C. Heating and cooling is carried out by circulating carbon dioxide. By changing the fuels loaded in the central region and by altering the temperature, a variety of neutron spectra can be produced. Small samples or single fuel elements can be introduced into the center of the reactor for making reactivity measurements. These measurements can be made either by an oscillator method, in which the amplitude of reactor power modulation is determined while the sample is regularly moved in and out of the reactor, or by period measurements. (J.F.P.)

1544 DEVICE FOR COLLECTING ACTIVE GASES ON THE SURFACE OF A SWIMMING POOL REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,348,527. Dec. 2, 1963. Filed Nov. 28, 1962.

A device is provided for preventing the active gases which may be liberated from the free surface of the mass of water from spreading into the hall of the reactor and for conducting the gases towards devices for storing, filtering and discharging them to the atmosphere. The gases are collected by means of a partially immersed substantially conical deflector having its apex submerged in the water. Helical ribs are disposed perpendicularly to the generatrices in order to enable the gases to spread as uniformly as possible around the periphery of the deflector. An annular collector casing is disposed around the periphery of the reactor pool and suction means suck air and active gases into the casing through apertures formed in the latter slightly above the free level of the water in the pool. (IIB)

1545 NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,383,260. Nov. 16, 1964. Priority date Dec. 26, 1962, United States.

The invention relates to a very high flux nuclear reactor for use in research. In such reactors a circular central flux trap is preferable, as it tends to eliminate power peaking along the circumference of the interface. The core of said reactor is shaped in cross section like a regular hexagon with a central hole of the same shape. The core comprises a plurality of fuel elements shaped in cross section like a rhombus and arranged in a plurality of hexagonal rings around the central hole. The fuel elements are composed of a number of parallel fuel plates and disposed next to the boundaries of the core parallel thereto. The fuel content of the fuel plates in the fuel elements located next to the boundaries of the core is graded upwardly from the boundaries towards the center of the core. (IIB)

1546 FAST FUEL TEST REACTOR. Astley, Eugene R.; Finch, Lester M.; Hennig, Robert J. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,982. Oct. 19, 1965.

A fast reactor is described including a central vertical process tube and a plurality of process tubes arranged in concentric hexagons around the central tube in a skewed-conical relation, said process tubes including a twisted hexagonal tapered portion containing a fuel assembly, which portions geometrically mate one with another to define a core of minimum voids. (AEC)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology
CHEMISTRY — Radiochemistry
CHEMISTRY — Separation Processes and Procedures
HEALTH AND SAFETY

Refer also to abstract 1352.

1547 (CEND–512) ANALYSIS OF FISSION PRODUCT ACTIVITY EFFECTS FOR THE ELK RIVER REACTOR. Klotz, R. J. (Combustion Engineering, Inc., Dunedin, Fla. Nuclear Div.). Oct. 1964. Contract AT(11-1)-651. 56p. Dep. mn; CFSTI $3.00 cy, $0.50 mn.

The maximum permissible stack activity release rates for the Elk River Reactor (ERR) were determined using the best available meteorological data available. Included are separate dilution factors or atmosphere dispersion factors for iodine and other fission products. With the maximum permissible stack release rates determined, the consequences of a fuel element failure were examined. The gaseous fission product activities released from a failed fuel element by a burst, and from continuous operation following a failure, were calculated for a maximum-power and an average-power fuel element in the ERR core. If a maximum-power element should fail after operating continuously for several days, and if all the activity accumulated in the space between the fuel and cladding should be released instantaneously under the worst possible meteorological conditions, and if the effect of stack height were negligible, a person at the nearest boundary could receive one-tenth of his yearly dose. It is concluded that activity release from a fuel element failure should not limit the operation of the plant. The analysis indicates also that it is possible to continue operation with many maximum-power elements failed if the off-gas system is operating as designed. Studies of the gaseous and particulate fission product activity in the containment building following a fuel element failure were made to determine the effect on plant operation. The results indicate that a cladding failure during reactor operation, at a time when the off-gas system is not operating, can lead to excessive airborne activity levels in the containment building. Operation of the off-gas system does reduce the airborne activity within the containment building but the amount of reduction is a strong function of the ability of the off-gas system to strip non-condensible gases out of the primary system. (auth)

1548 (DPSPU–65-30-30) HANDLING OF LOW AND MEDIUM LEVEL LIQUID WASTE AT SAVANNAH RIVER PLANT. Girdler, R. M. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Sept. 1965. Contract AT(07-2)-1. 18p. (CONF-651202–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

For Presentation at Symposium on Practices in the Treatment of Low and Intermediate Level Radioactive Waste, Vienna.

A discussion is presented of the various means used to control the radioactivity in liquid wastes which may reach the environment by way of drainage to the Savannah River: seepage basins, distillation, ion exchange on synthetic zeolite, tank storage, and aging and settling. The costs of each method are given. (D.L.C.)

1549 (ORNL-3811) LABORATORY DEMONSTRATION OF THE TWO-STEP PROCESS FOR DECONTAMINATING LOW-RADIOACTIVITY-LEVEL PROCESS WASTE WATER BY SCAVENGING-PRECIPITATION AND FOAM SEPARATION. Davis, W. Jr.; Kibbey, A. H.; Schonfeld, E. (Oak Ridge National Lab., Tenn.). Oct. 1965. Contract W-7405-eng-26. 32p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

The two-step process for decontaminating low-level radioactive waste water was demonstrated in two continuous runs on a laboratory scale. The process consists in first precipitating and eliminating most of the suspended solids and soluble hardness in a suspended-bed sludge column and then producing further decontamination in a countercurrent foam column. Overall decontamination factors for Sr, Co, Ru, and Ce were $>3.7 \times 10^3$, 2.3 to 4, 2 to 5, and 50 to 180, respectively. The cesium decontamination factor was 20 when 60 ppm of grundite clay (baked at 600°C for 20 min) was added to the low-level waste (LLW) during the precipitation step. The ratio of surface to liquid flow rate is the crucial factor governing satisfactory strontium decontamination in the foam column. The metal ion decontamination factor in the foam-separation step is proportional to the metal ion distribution coefficient and inversely proportional to the volume reduction and liquid throughput. The cost of chemicals for this process is 26.6¢ per 1000 gal of LLW. Development of the process flowsheet required the study of several problems or variables. These included: (1) the effects of pH on precipitation of hardness ions; (2) the prevention of inhibitory effects of phosphates present in the waste water on the precipitation of calcium carbonate; (3) study of the sludge density as a function of liquid flow rate and bed depth; (4) the degree of biodegradability and fast quantitative analysis of surfactants; (5) the effect of splitting the feed of surfactant into the foam column; (6) volume reduction; and (7) recovery of surfactant. (auth)

1550 (RL-SA-50) REMOVING FISSION GASES AND IODINE FROM REACTOR EXHAUST AIR BY FOG SPRAY AND FOAM. Smith, M. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Aug. 2, 1965. Contract AT(45-1)-1350. 3p. (CONF-651101-35). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From 13th Conference on Remote Systems Technology, Washington, D. C.

Two tests were conducted on the ability of a fog spray system to remove ^{128}I from the exhaust air at one of the Hanford production reactors. The penetrations of 100-Curie releases of ^{128}I into the components of the system are given. A test was also conducted on the trapping of ^{41}Ar from the exhaust air by foam. (D.L.C.)

1551 (RL-SA–53) PLANT SCALE DEMONSTRATION OF PROMETHIUM RECOVERY AND PURIFICATION PROCESSES. Ritter, G. L.; Buckingham, J. S. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 17, 1965. Contract AT(45-1)-1350. 39p. (CONF-651010–1). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Electrochemical Society, 6th Regional AIChE Meeting, Union, Wash.

A slurry from an underground radioactive waste storage tank containing about 0.003 weight percent promethium-147 (total cation basis) was processed for recovery of the promethium. The promethium obtained was semi-purified by solvent extraction techniques to yield 75,000 curies. Approximately 45,000 curies of promethium at 98 weight percent purity was obtained from a chromatographic ion exchange final purification process. Process technology demonstrated during this effort included: (a) a solvent extraction flowsheet for the successful separation of promethium and other rare earths from principally iron, lead, and strontium contaminants; (b) a solvent extraction flowsheet for the removal of cerium, including the extremely radioactive cerium-144 and its decay daughter praseodymium-144, from the other rare earths; and (c) a chromatographic ion exchange system capable of handling kilocurie quantities of promethium. Results of the test

program have been helpful in defining areas for additional laboratory investigations and in designing flowsheets and equipment for the large-scale recovery and purification of promethium at Hanford. (auth)

1552 (UCRL–14320) WASTE MANAGEMENT PRACTICES AT LAWRENCE RADIATION LABORATORY, LIVERMORE Kvam, Donald J. (Lawrence Radiation Lab., Univ. of California, Livermore). Sept. 28, 1965. Contract W-7405-eng-48. 18p. (CONF-651202–2). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Symposium on Practices in the Treatment of Low and Intermediate Level Radioactive Waste, Vienna.

The waste management program has the functions of reducing waste generation and disposing of radioactive wastes. Retention tank waste, carboy wastes, and solid wastes are considered. The waste plant, dry waste container, waste packaging facility and waste press are described. (D.L.C.)

1553 ORGANIZATION OF A CENTRALIZED REMOVAL OF RADIOACTIVE WASTES FROM THE SITES OF THEIR ACCUMULATION. Sobolev, I. A.; Khomchick, L. M. Gigiena i Sanit., No. 5, 78-9(May 1965). (In Russian).

Safe removal of radioactive wastes from cities or industrial installations where they are generated and accumulated as a result of large-scale operation with isotopes can be best achieved by establishing one or several central sites that can be conveniently reached by an existing road network. Only solid and liquid wastes, the activity of which exceeds by a factor of 100 the activity of the maximum permissible concentrations for isotopes with half lives up to 60 days and by a factor of 10 that of isotopes with longer half lives, are collected in these central disposal areas. Liquid wastes with an activity of 1×10^{-4} C/l or more are accepted without a daily limit; lower-activity wastes are accepted only from installations that accumulate less than 200 l/day; if the daily effluents are larger, these installations must operate their own disposal plants. Liquid waste must be pretreated to have a pH ≅ 7. Solid wastes must be packaged in order to exclude the possibility of dust formation during loading and unloading operation and transportation; the surface activity of the packages should not exceed 70 mr/hr and the dose rate in the driver's cab should be kept below 0.8 μr/sec. A bill of lading containing all the necessary technical data must accompany each shipment. Dosimetric control is maintained at each phase of the operation. Special trucks are provided for ultimate removal from these centralized locations; the driver serves as health physics agent and carries out the measurements. (TTT)

1554 CONVERSION OF IRRADIATED FUEL SWARF TO A STABLE CERAMIC SUITABLE FOR LONG-TERM STORAGE. Hilton, D. A.; Buddery, J. H. (Berkeley Nuclear Labs., Gloucestershire, Eng.). Ind. Eng. Chem., Process Design Develop., 4: 400-3(Oct. 1965).

A method is described for the conversion of irradiated fuel swarf, of the type obtained in the postirradiation examination of uranium-Magnox fuel elements, into a stable ceramic by reaction with a 5 wt % cupric oxide–32 wt % alumina—63 wt % lead borate glass mixture. The process requires a minimum of handling and is carried out by a three-stage heating sequence for periods of 1 hr each at 350, 500, and 700°C. Losses of fission products throughout the reaction were less than 20 ppm of the gross β and γ activities and the product formed was suitable for long-term storage. Brief details of the resistance of the ceramic to water leaching and radiation are given. (auth)

1555 SELECTIVE SORPTION REACTIONS OF CESIUM WITH SOIL MINERALS. Tamura, T. Nucl. Safety, 5: No. 3, 262-5(Spring 1964).

A review of work done on retention of Cs from radioactive waste solutions by soils, Cs sorption by clay minerals, and Cs–K relations with soils. (J.R.D.)

1556 GLASS IN NUCLEAR TECHNOLOGY. Robredo, J. Verres Refractaires, 18: 308-18(July-Aug. 1964).

The contribution of the glass industry to nuclear technology is considered. Two questions are discussed in detail: elimination of radioactive wastes by incorporating them in vitreous materials and manufacture of fuel elements by incorporating fissile matter in vitreous systems. (French Technical Press, No. 1, 1965)

1557 LOW LEVEL WASTE PILOT PLANT INSTRUMENT INSTALLATION /Q-2233/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1285).

14 drawings.

Instrument installation circuits are shown for the panel board, electrical equipment, pneumatic equipment, manometers, flow indicators, pressure gauges, and radiation detectors used in the Low Level Waste Pilot Plant. (For Details, See TID-4100) (M.C.G.)

GENERAL AND MISCELLANEOUS

1558 (BNL–9404) GENETIC INFLUENCES ON EXPERIMENTAL HYPERTENSION IN THE RAT. Dahl, Lewis K. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 20p. (CONF-650714–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From International Club on Arterial Hypertension Symposium, Paris.

It was found that the genetic background of two selectively inbred strains of rats markedly influences the development of experimental hypertension from: NaCl ingestion, DOCA-NaCl, unilateral renal artery compression without added NaCl, cortisone, and adrenal regeneration. It was suggested that the results have relevance to hypertension in man. A general hypothesis was proposed in which genetic and non-genetic factors are considered to interact to produce hypertension. There is clinical evidence to support this hypothesis. (auth)

1559 (BNL–9573) HIGH TEMPERATURE CORROSION TESTING BETWEEN SILICA AND LEAD, LEAD BROMIDE AND BROMINE. McNicholas, J. J. (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 11p. (CONF-651017–1). Dep. mn; CFSTI $1.00 cy, $0.50 mn.

From Electrochemical Society Meeting, Buffalo.

As part of an electrochemical energy converter program, individual long term compatability tests at 900°C were made between silica glass and substances lead, lead bromide, and bromine. Lead was tested using argon and hydrogen for 500 hr and 2000 hr, respectively. Bromine was tested for 200 hr. Lead and lead bromide were tested simultaneously for 500 hr. 200 hr were accumulated with lead, lead bromide, and bromine simultaneously present. Microscopic examination and chemical analysis showed no corrosion in all cases. (auth)

1560 (CALT–473-5) IMPURITY EFFECTS ON BASAL SLIP IN ZINC. Report No. 4. Adams, K. H.; Vreeland, T. Jr.; Wood, D. S. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). July 1965. Contract AT(04-3)-473. 41p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

Basal stress-strain behavior, dislocation density, and the strain rate sensitivity of the flow stress were measured at room temperature in zone refined zinc, 99.999 percent zinc, and zinc containing 0.0025 and 0.02 at percent aluminum. No significant change in the strain rate sensitivity of the flow stress occurs with the addition of aluminum. Changes in substructure and nonbasal dislocation density accompanying addition of aluminum were observed. The effect of the aluminum on the basal stress-strain behavior is explained in terms of changes in nonbasal dislocation density which determines the separation distance of junctions between basal and nonbasal dislocations. The onset of basal slip is associated with the breaking of attractive junctions. The change in basal dislocation density was found to be proportional to the one-third power of the plastic shear strain, independent of purity. (auth)

1561 (IS-T–31) METAL CARBONYL COMPLEXES OF POLYCYCLIC PHOSPHITE ESTERS [Thesis]. Hendricker, David George (Ames Lab., Iowa State Univ. of Science and Tech.). Aug. 1965. Contract W-7405-eng-82. 155p. Dep. mn; CFSTI $5.00 cy, $1.00 mn.

Submitted to Iowa State Univ. of Science and Tech., Ames.

The preparation and characterization of metal carbonyl complexes of 4-methyl-2,6,7-trioxa-1-phosphabicyclo-[2.2.2]octane, $P(OCH_2)_3CCH_3$, 4-ethyl-2,6,7-trioxa-1-phosphabicyclo[2.2.2]octane, $P(OCH_2)_3CC_2H_5$, and 2,8,9-trioxa-1-phospha-adamantane, $P(OCH)_3(CH_2)_3$, are described. Substitution products obtained from $Ni(CO)_4$ include compounds of the type $Ni(CO)_{4-x}(Ligand)_x$ where x = 1, 2, 3, or 4. Synthesis of the mono- and disubstituted complexes of $Fe(CO)_5$, $Cr(CO)_6$, $Mo(CO)_6$, and $W(CO)_6$ with these ligands is also reported. A study of the carbonyl infrared stretching frequencies implies that these ligands are equal to or greater than trialkyl and triaryl phosphites in pi-bonding ability. The spectra indicate that the $Ni(CO)_3$ (Ligand) complexes are tetrahedral and that the disubstituted complexes of the carbonyls other than nickel are of a trans configuration. The far infrared spectra of the ligands and some of the compounds are reported. The proton NMR spectra of all the compounds were observed. Trends in the chemical shifts as a function of the degree of substitution and complex geometry are noted. The proton spectra of the disubstituted complexes exhibit varying degrees of phosphorus-phosphorus coupling. Crude attempts to calculate the magnitude of this coupling which appears to be a function of complex geometry, metal atom, and pi-bonding ability of the ligand are made. The ^{31}P NMR spectra of selected complexes are also reported. The proton NMR spectra of the complexes $Ni[P(OCH_3)_3]_4$ and $Ni[P(OC_2H_5)_3]_4$ are also found to exhibit P-P coupling. No evidence for the dissociation of these compounds in benzene solutions using a vapor pressure osmometer indicate monomeric behavior over a concentration range of 0.006 to 0.023 Molar. (auth)

1562 (NYO–2684-39) ALLOYS OF THE NOBLE METALS. Annual Progress Report, July 1, 1964–August 15, 1965. (Mellon Inst., Pittsburgh, Pa.). Aug. 19, 1965. Contract AT(30-1)-2684. 13p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Short summaries are presented of work on Cu, Ag, and Au and their alloys: deformation of hcp intermediate phases, massive and martensitic phase transformations, electronic specific heats, and lattice spacings. (D.L.C.)

1563 (ORNL-AMPIC–2) DIRECTORY OF INTERNATIONAL WORKERS IN THE FIELD OF ATOMIC AND MOLECULAR COLLISIONS. (Oak Ridge National Lab., Tenn.). Sept. 1965. Contract W-7405-eng-26. 53p. ORNL Free.

A list is presented of scientists engaged or interested in atomic and electronic collisions. The list was derived from attendees at scientific conferences, particularly the 2nd, 3rd, and 4th International Conferences on Atomic and Electronic Collisions. The names are arranged alphabetically. (D.L.C.)

1564 (ORO–629) TRANSFERENCE OF NON-NUCLEAR TECHNOLOGY TO INDUSTRY. Committee Report to Oak Ridge Operations Office, United States Atomic Energy Commission. (Oak Ridge Operations Office (AEC), Tenn.). July 2, 1965. 48p. Dep. mn; CFSTI $2.00 cy, $0.50 mn.

A study was made of the utilization of non-nuclear technology developed in AEC programs. Of the three fields studied (materials, mechanical development, and fluorine technology), only mechanical development was found to have a significant reservoir of technology that has not been transferred to industry. A summary is presented of the recommendations made. (D.L.C.)

1565 (RPI–1999-6) INTERACTIONS AND STRUCTURE OF SIMPLE ELECTROLYTES IN POLAR ORGANIC SOLVENTS. Annual Progress Report, 1965. Janz, George J. (Rensselaer Polytechnic Inst., Troy, N. Y.). Oct. 1965. Contract AT(30-1)-1999. 8p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The scope and status of the research on non-aqueous ionic solutions are described. Measurements of the properties of $AgNO_3$ in anhydrous CH_3CN and C_6H_5CN show that ion pairs and possibly higher aggregates are formed at high concentrations, CH_3CN has a more open solvent structure than C_6H_5CN or H_2O, and strong solute-solvent interactions occur in CH_3CN with evidence for $Ag(CH_3CN)_4^+$ complexes. Splitting of the degenerate stretching vibration of the nitrate ion in solutions is also observed. Other work in progress is described briefly. (D.L.C.)

1566 (SC-DC–65-1545) SHOCK TESTING WITH HIGH EXPLOSIVE INITIATED GAS DETONATIONS.

Sigmon, W. M. Jr. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1965. Contract AT(29-1)-789. 50p. (CONF-651013-1). Dep. mn; CFSTI $2.00 cy, $0.50 mn.

From Shock and Vibration Symposium, New Orleans.

A simple, convenient method was developed for controlling pulse rise times in explosive gas tests. The method devised for control of rise times, or sweep velocities, consists of using small strands of solid high explosives to propagate the gas detonation. By properly positioning the explosive strands relative to the test item surface, a wide range of shock pulse sweep velocities is possible. This method lends itself well to large or complex shapes. Strands of explosive are arrayed in a frame at the proper orientation with the test item. The assembly is then placed in a detonation chamber filled with an explosive gas mixture. The HE initiation provides the proper sweep velocity or rise time while the pulse amplitude and duration are controlled by the setup parameters. Tests to investigate the performance of this method were conducted in four types of setups: (1) frangible wooden chambers; (2) a rectangular steel chamber; (3) a 16-inch diameter, 14-foot long detonation tube; and (4) a 26-inch diameter, 130-foot long tube. The gas mixture ordinarily used was hydrogen and oxygen, with Primacord as the solid explosive. Experimental results were quite encouraging and generally confirmed predictions. Shock front sweep velocities of as high as 30,000 feet per second were obtained. The results indicate that high explosive initiated gas detonations will provide pressure pulses controllable in amplitude, duration, and rise time for blast load simulation and other shock tests requiring similar pulses. (D.L.C.)

1567 (SC-RR-65-380) GAS-GENERATING TECHNIQUE FOR RECOVERING SUBMERGED OBJECTS. Sprague, C. W. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1965. Contract AT(29-1)-789. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

A gas-generation technique is described for the recovery of deeply submerged massive objects. Techniques for the attachment of the recovery equipment from remote locations are also presented. (auth)

1568 (STI/DOC/10/42) IAEA RESEARCH CONTRACTS. Fifth Annual Report. Technical Reports Series No. 42. (International Atomic Energy Agency, Vienna (Austria)). Apr. 1965. 134p. IAEA US $1.00; S 21,-; 6/-stg; F.Fr.4,-; DM 3,20.

Summaries are presented of 26 final reports from contracts which were completed during 1964. The summaries are arranged into seven sections as follows: radioactive waste management and environmental research, health physics and radiation protection, radiation biology, safeguards methods, studies involving reactors, radioisotope applications in agriculture, and radioisotope applications in medicine. Separate abstracts were prepared for all seven sections. A categorized bibliography is included. (D.L.C.)

For abstracts of individual sections see: 8, 9, 63, 163, 218, 234, and 1474.

1569 (TID-3731) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE ISSUED OR IN PROGRESS DURING THE PERIOD, AUGUST-SEPTEMBER 1965. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 15p. DTI Extension Free.

A list of 78 bibliographies of interest to the Atomic Energy Program is presented. Subject, author, and report number indexes are included. (D.L.C.)

1570 (TID-22150) THE ADSORPTION OF n-UNDECANOIC AND n-NONADECANOIC ACIDS ON COPPER AND NICKEL SINGLE CRYSTALS [Thesis]. Grindstaff, Teddy Hodge (Tennessee Univ., Knoxville). Aug. 1963. 140p. Dep. mn; CFSTI $4.00 cy, $1.00 mn.

A study was made of the adsorption of carbon-14-labeled n-nonadecanoic acid and n-undecanoic acid on annealed and on oxidized single crystals of copper and of nickel. Nonadecanoic acid was found to be adsorbed in islands with the molecules virtually perpendicular to the surface on copper and nickel crystals; after an adsorption time of about 64 hours the surface was completely covered with a monolayer of the acid. Copper and nickel crystals were isotropic in their adsorption of nonadecanoic acid. Oxidized copper crystals were found to be anisotropic in their adsorption of nonadecanoic acid; the (100) face was roughened the most by oxidation and this face adsorbed more acid than either the (110), (111), or (311) face. The equivalent of a monolayer that followed the contours of the oxidized surfaces was not adsorbed after an adsorption time of 128 hours. The (100) face of a copper crystal adsorbed more undecanoic acid than either the (110), (111), or (311) face for adsorption times that were less than about 17 hours; if the adsorption time was longer than this the crystal was isotropic in adsorbing undecanoic acid. The equivalent of a monolayer in which the molecules were perpendicular to the surface was adsorbed after about 64 hours. Oxidized copper crystals were anisotropic in their adsorption of undecanoic acid; the rate of adsorption was fastest on the (100) face, slowest on the (311) face, and faster on the (111) face than on the (110) face. The amount of acid adsorbed on each face was found to increase to a maximum after an adsorption time of about 1 minute and then gradually decrease until a constant value was reached after about 17 hours. An explanation is given of the adsorption of nonadecanoic and of undecanoic acid on copper and oxidized copper crystals. Desorption studies were made on copper and oxidized copper crystals that had been allowed to adsorb undecanoic acid and nonadecanoic acid. It was consistent with these studies to assume that either the copper (I) or copper (II) acid soap was formed on both oxidized and unoxidized surfaces. The amount of undecanoic acid adsorbed on either nickel, copper, or oxidized copper crystals was shown to decrease as the surface aged; unoxidized nickel and copper crystals were not anisotropic in their adsorption of undecanoic acid when their surfaces were 15 hours old. Aged oxidized copper crystals were anisotropic in their adsorption of undecanoic acid but the variation in the density of molecules on the plane of the surface with crystal face was probably due to the roughness factor varying with crystal face. (D.L.C.)

1571 (TID-22186) OXYANIONS AND PEROXIDES—THEIR CONSTITUTIONS AND REACTION MECHANISMS. Annual Report. Edwards, John O. (Brown Univ., Providence, R. I. Dept. of Chemistry). Aug. 1, 1965. Contract AT(30-1)-1983. 16p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The following research projects are being conducted: oxidation of nitrite ion by peroxydisulfate ion, oxidation of methanol by peroxydisulfate ion, oxidation of ethanol by peroxydisulfate ion, reaction of hydrazine with hydrogen peroxide, chemistry of oxaziranes (oxaziridines), paramagnetic peroxyborates, solution chemistry of boric acid, solution chemistry of chlorite ion, isotope studies of peroxide decomposition, and miscellaneous studies. (D.L.C.)

1572 (TID-22196) THE DEPENDENCE OF LIGHT SCATTERING BY POLYMER FILMS ON POLARIZATION ANGLE, AND ITS RELATIONSHIP TO THE RANDOMNESS OF ORIENTATION FLUCTUATIONS. Technical Report No. 74. Stein, R. S.; Erhardt, P.; Adams, G. (Massachusetts Univ., Amherst. Polymer Research Inst.). July 1, 1965. Contract Nonr 3357(01). 67p. Dep. mn; CFSTI $3.00 cy, $0.75 mn.

A theory for scattering from polymer films having nonrandom-orientation fluctuations is presented that involves a parameter ϵ that varies between +1 for rodlike orientation correlations and –1 for dislike correlations. A value of $\epsilon = 0$ corresponds to random correlations, where the probability of optic axes being parallel is independent of the relative orientation of the axes and their line of separation. The angular variation of the scattering, characterizing the orientation of a polarizer in the incident light beam, is found to depend upon ϵ. Intensity variations are calculated for the cases where an analyzer in the scattered beam has its depolarization direction either parallel or perpendicular to that of the polarizer. This approach is useful for describing the morphology of a crystalline polymer with organization less than that of a spherulitic polymer but greater than random. (auth)

1573 (TID-22314) IMPURITY DISTRIBUTION IN SINGLE CRYSTALS. I. IMPURITY STRIATIONS IN NON-

ROTATED InSb CRYSTALS. Morizane, K.; Witt, A. F.; Gatos, H. C. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). [1964]. Contract AT(30-1)-3208. 18p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

Single crystals of InSb were pulled without rotation from the melt in the presence of tellurium or selenium impurity employing a Czochralski-type apparatus. The formation of pronounced periodic and nonperiodic impurity striations was observed; their appearance and origin were studied as a function of the thermal conditions prevailing in the immediate vicinity of the solid-melt interface. It was concluded that the formation of such striations is the result of temperature fluctuations at the interface brought about by convection currents in the melt which in turn are primarily by sharp temperature gradients in the growing crystal near the interface. (auth)

1574 (UCRL–13156) THE MOIRE FRINGE METHOD FOR STRAIN ANALYSIS. Beadle, Charles W. (California Univ., Davis. Dept. of Engineering). June 1965. Contract W-7405-eng-48. 22p. Dep. mn; CFSTI $1.00 cy, $0.50 mn.

The optical phenomena known as moire is reviewed as a means of determining strains over a flat field. The moire effect is produced by the superposition of two similar arrays of lines or dots which geometrically interfere with each other and produce alternate light and dark areas or "moire fringes." If one of these arrays is printed on a specimen and a stationary array printed on a transparency is held above it, moire fringes will be produced as the first array is distorted from the strains in the specimen. These fringes can be interpreted to give the strain field. This study was devoted to means of applying arrays of lines to the specimen surface. The technique would be invaluable for determining whole strain fields under conditions of high temperatures, dynamic loading, creep, and in very fragile structures. (auth)

1575 (UCRL–16409) OPTICAL PROPERTIES OF ADENYLIC ACID AND ITS OLIGOMERS [Thesis]. Davis, Stephen L. (Lawrence Radiation Lab., Univ. of California, Berkeley). Aug. 1965. Contract W-7405-eng-48. 240p. Dep. mn; $6.00 cy, $1.25 mn.

Experiments were conducted on the monomer units, several dimer units, and longer polymers, the latter composed only of adenylic acid residues. The experiments emphasized some of the differences in properties between the monomer and dimer of adenylic acid. The dimer of adenylic acid forms complexes with mercuric chloride more readily than does the monomer, and longer polymers of adenylic acid, more readily still. As one changes the solvent environment of adenylic acid dimer from water to binary solutions composed of ethanol/water or trimethyl phosphate/water, the spectral characteristics of the dimer come to resemble those of the monomer. This phenomenon was investigated in terms of conformational changes likely involved. No splitting at room temperature was observed in the absorption spectrum of the adenylic acid dimer. Some of the experimental procedures were used to look at properties of other pertinent molecules (all constituents of nucleic acids, or analogs of such constituents). (D.L.C.)

1576 THE INCORPORATION OF NUCLEAR ENERGY INTO THE SPANISH ELECTRICAL SYSTEM. Pascual, F.; Molina, J. Energia Nucl. (Madrid), 9: 12-21(1965). (In Spanish).

The evolution of production of electrical energy predicted for the future was studied. Beginning with the present situation of the means of generation of electrical energy and of the increases that can occur in the future as a result of the impoverishment of the natural resources, the moment for incorporation of nuclear power plants was established. With the consideration of the problems that this incorporation can cause, an attempt was made to establish a program for the installation of nuclear power plants up to 1975. The years 1970 and 1975 were studied in detail. (tr-auth)

1577 THE ARCHITECT IN THE NUCLEAR AGE. Munce, J. F. London, Iliffe Books Ltd., 1964. 241p.

Problems posed by the presence of radioactivity in designing buildings are discussed. Topics covered include: the physics of nuclear fission, reactor classification, small power and training reactors, power reactors, accelerators, nuclear energy developments in Great Britain and United States, the Euratom program, nuclear energy in communist countries, radioactivity in medicine, radioactive laboratories, irradiation of food, health hazards, safety precautions and insurance, protection, process materials, structural materials and methods, and architectural opportunity of nuclear fission. (M.C.G.)

1578 RECOVERY OF SULFURIC ACID FROM AN AQUEOUS SOLUTION CONTAINING METAL VALUES BY EXTRACTION WITH TERTIARY AMINES. Crouse, D. J. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,526. Oct. 12, 1965.

A method of recovering sulfuric acid from aqueous solutions by extraction with a tertiary amine containing branched carbon chains is described. The use of these amines as extractants permits efficient stripping with water, thus providing a product containing sulfuric acid in a useful concentration. (AEC)

1579 POLYTRIFLUOROCARBON ADHESIVE COMPRISING AN ALPHA-CARBOXYMETHYLACRYLATE COPOLYMER REACTED WITH AN EPOXY AND A POLYAMINO-POLYAMIDE RESIN. Horstman, Harold R. (to U. S. Atomic Energy Commission). U. S. Patent 3,211,602. Oct. 12, 1965.

A method is considered of joining chlorotrifluoroethylene polymers and copolymers to themselves and other materials comprising applying to the surfaces to be joined coatings of the condensation product of methyl methacrylate and an α-carboxymethylacrylate, the condensation product of dimerized linoleic acid and diethylenetriamine and the condensation product of epichlorohydrin and bis(4-hydroxyphenyl)dimethylmethane, allowing said coating to dry to tackiness, and pressing the coated surface together and curing the joined material and adhesive. (AEC)

1580 METHOD FOR PRODUCING P-I-N SEMICONDUCTORS. Blankenship, J. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,212,940. Oct. 19, 1965.

The fabrication of a p-i-n semiconductor is proposed wherein a highly n-type skin is formed on one side of a silicon wafer, a controlled amount of Li is diffused through it, and an intrinsic condition is produced in the wafer by drifting lithium under the influence of an electric field along a selected path while the n-type skin traps the Li in the wafer. (AEC)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

A

AEROJET-GENERAL NUCLEONICS, SAN RAMON, CALIF.
Prog. rpt. on Army GCR systems, 4–6/65, 20: 1467 (IDO-28649)

AKADEMIYA NAUK UKRAINSKOI SSR, KHARKOV. FIZIKO-TEKHNICHESKII INSTITUT.
Theory of polarization phenomena in quantum electrodynamics, 20: 996 (NP-15204)

AKTIEBOLAGET ATOMENERGI, STOCKHOLM (SWEDEN).
Measured and predicted variations in fast neutron spectrum when penetrating laminated Fe–D_2O, 20: 1304 (AE-196)

AKTIEBOLAGET ATOMENERGI, STUDSVIK (SWEDEN).
Fission product release under accident conditions and radiological consequences, 20: 569 (CONF-650407, pp 603-8)

ALLGEMEINE ELEKTRIZITAETSGESELLSCHAFT, FRANKFURT AM MAIN (WEST GERMANY).
Model for evaluating effects of accidental release of radioactive materials from power reactors, 20: 583 (CONF-650407, pp 970-83)

ALLIS-CHALMERS MFG. CO., BETHESDA, MD. ATOMIC ENERGY DIV.
Prog. rpt. on Elk River Reactor operations, semiannual, 7–12/64, 20: 1453 (ACNP-65532)

ALLIS-CHALMERS MFG. CO., WASHINGTON, D. C. ATOMIC ENERGY DIV.
ERR stack monitor study, 20: 1452 (ACNP-63628)

AMERICAN MACHINE AND FOUNDRY CO., GREENWICH, CONN.
Nuclear weapons effects on shipboard electronic systems. II., 20: 617 (AD-611540)

AMES LAB., IOWA STATE UNIV. OF SCIENCE AND TECH.
Metal carbonyl complexes of polycyclic phosphite esters, 20: 1561 (IS-T-31)
Neutron activation analysis of rhenium in rocks, 20: 226 (IS-T-39)
Pneumatic-mechanical high-energy-rate extrusion of yttrium, 20: 783 (IS-1227)

ARGONNE NATIONAL LAB., ILL.
Calculation demonstrating effect of Zr–H_2O reaction on analysis of loss-of-coolant accident, 20: 582 (CONF-650407, pp 938-69)
Compilation of requests for nuclear cross section measurements, 20: 1161 (WASH-1057)
Preparation of metals by magnesium–zinc reduction. I., 20: 741 (ANL-7057)
Preparation of metals by magnesium–zinc reduction. II., 20: 742 (ANL-7058)
Quality evaluation of CP-5 reactor fuel, 20: 1533 (CONF-650532-2)
Tumor induction in mice by radioactive thymidine, 20: 66 (TID-22292)

ARMY ENGINEER NUCLEAR CRATERING GROUP, LIVERMORE, CALIF.
Isthmian Canal studies, 1964. Annex III, 20: 471 (PNE-1999)

ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISS.
Preshot investigations for project Pre-Schooner, Buckboard Mesa, Nevada Test Site, 20: 511 (PNE-505P)

ASSOCIATION CLAUDE BERNARD, PARIS (FRANCE).
Prog. rpt. on immunologically competent cells, annual, 1964, 20: 55 (EUR-2469.f)

ATOMIC ENERGY COMMISSION, WASHINGTON, D. C.
Nuclear reactors in the Soviet Union, 20: 1351 (WASH-1060)
Power reactor accidents in perspective, 20: 580 (CONF-650407, pp 908-20)

ATOMIC ENERGY ESTABLISHMENT, TROMBAY (INDIA).
Containment and siting of high power reactors, 20: 1460 (CONF-650407, pp 1015-34)

ATOMIC ENERGY ESTABLISHMENT, TROMBAY (INDIA). ANALYTICAL DIV.
Release of fission gases and iodines from defected UO_2 fuel elements of different lengths, 20: 890 (EXP-NRX-21406)

ATOMIC ENERGY OF CANADA LTD., CHALK RIVER (ONTARIO).
Fission gas and I release into coolant systems from defects in UO_2 fuel elements, 20: 555 (CONF-650407, pp 1-37)
FREAK: A G-20 computer program for making frequency distribution tables, 20: 733 (CRT-1167)
Future of nuclear power in Canada, 20: 1454 (AECL-2293)
Measurement of fast fission ratios in natural uranium, 20: 1147 (CRRP-1220)
Sheath temperatures. G-20 computer program for fuel bundles, 20: 480 (AECL-2269)
Temperature-dependent resonance integrals in UO_2 and ThO_2, 20: 1148 (CRRP-1222)

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL (ENGLAND).
Deposition of iodine vapor on surfaces, 20: 215 (CONF-650407, pp 142-77)
Determination of plutonium by potentiometric titration, 20: 222 (AERE-R-4975)
Equilibrium metal vapor pressures over alkaline-earth carbides, 20: 810 (AERE-R-5011)
Equilibrium oxygen pressure over stainless steels and relation to reactor fuel stability, 20: 277 (AERE-R-4942)
Equipment for maintenance of high-purity atmospheres in glove boxes, 20: 475 (AERE-M-1491)
Iodine cleanup in steam suppression system, 20: 576 (CONF-650407, pp 776-804)
Proposed specification of computing system using remote consoles, 20: 731 (AERE-M-1627)
Radioiodine adsorption on particulate matter, 20: 216 (CONF-650407, pp 242-75)
Reduction of sulfur dose threshold in the AERE criticality dosimeter, 20: 647 (AERE-M-1631)
Slow neutron calibration of film and other γ dosimeters, 20: 648 (AERE-R-4960)
Vaporization of europium dicarbide, 20: 811 (AERE-R-5012)

ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON (ENGLAND).
Reactor safety modeling techniques based on the accident to SL-1 boiling water reactor, 20: 1455 (AWRE-E-3/65)
Scale-model investigation of flow from open end of shock tube of rectangular cross section, 20: 912 (AWRE-O-61/65)
Shock tube 30 × 18 in., 20: 619 (AWRE-O-59/65)
Thin film thermometer as triggering and measuring device in a shock tube, 20: 618 (AWRE-O-58/65)

ATOMICS INTERNATIONAL, CANOGA PARK, CALIF.
Fission product retention and plating behavior in liquid sodium systems, 20: 557 (CONF-650407, pp 73-93)
Magneforming process for fabrication of thin-wall tungsten cylinders, 20: 781 (AI-65-12)
Magnetic moments and vehicle torques in the SNAP 10A, 20: 1528 (NAA-SR-11207)

Preliminary design of mercury vapor supersaturation experiment, 20: 481 (NAA-SR-Memo-11194)
SNAP 10A, expansion compensator, 20: 1527 (NAA-SR-9778)
Sodium fires and the release characteristics of particulates and fission products, 20: 558 (CONF-650407, pp 94-117)
Thermal model for use in SNAP system simulation, 20: 1529 (NAA-SR-Memo-10961)

AUTHORITY HEALTH AND SAFETY BRANCH, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, RISLEY (ENGLAND).
Handbook of criticality data. I., 20: 1410 (AHSB(S)HANDBOOK-1 (1st. Rev.))

AVCO-EVERETT RESEARCH LAB., EVERETT, MASS.
Effect of coherent radiation on stability of crossed-field electron beam, 20: 499 (NP-15541)

B

BATTELLE MEMORIAL INST., COLUMBUS, OHIO.
Critical analysis of the blowdown accident, 20: 570 (CONF-650407, pp 609-40)
Fission-product deposition in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
Fission product release from coated particle fuels under accident conditions, 20: 556 (CONF-650407, pp 56-72)
Prog. rpt. on analysis of information on reinforced openings in pressure vessels, 2/63–2/64, 20: 457 (BMI-X-276)
Radiation stability of uranium mononitride, 20: 888 (BMI-1731)

BATTELLE-NORTHWEST, RICHLAND, WASH. PACIFIC NORTHWEST LAB.
Accomplishments of Plutonium Recycle Test Reactor, 20: 1458 (BNWL-SA-308)
Chemical metallurgy, 20: 762 (BNWL-120, pp 5.1-18)
Compositional and pressure effects in the plutonium–gallium system, 20: 815 (BNWL-SA-209)
Corrosion evaluation of high-silicon aluminum alloys, 20: 763 (BNWL-125)
Corrosion of Zircaloy-2, wear and crevice effects, 20: 764 (BNWL-SA-313)
Fatigue behavior of plutonium-1.0 wt.% gallium δ-stabilized plutonium, 20: 816 (BNWL-SA-210)
Materials engineering, 20: 746 (BNWL-120, pp 6.1-11)
Parametric evaluation of DTPA, EDTA, and HEDTA for ion exchange purification of promethium, 20: 429 (BNWL-69)
Physical metallurgy, 20: 745 (BNWL-120, pp 3.1-22)
Prog. rpt. on metallurgy, 4–6/65, 20: 744 (BNWL-120)
Prog. rpt. on study of W–Tc alloys, 4–7/65, 20: 814 (BNWL-142)
PuO_2–UO_2 experiment in the EBWR, 20: 1457 (BNWL-126)
Reactor metals research, 20: 889 (BNWL-120, pp 4.1-59)
Uptake and retention of ^{65}Zn from certain foods, 20: 553 (BNWL-SA-293)

BETTIS ATOMIC POWER LAB., PITTSBURGH, PA.
Evaluation of cross sections of fissionable nuclides, 20: 1160 (WAPD-T-1847)

BETTIS ATOMIC POWER LAB., WEST MIFFLIN, PA.
Special thermocouple performance PWR-1, Seed 4, 20: 1477 (WAPD-PWR-TE-166)

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Character of effluent material from a transient test of a nuclear rocket engine, 20: 566 (CONF-650407, pp 557-65)
Equilibrium temperature for the plutonium α-β transformation, 20: 822 (LA-DC-7278)
High-temperature thermal diffusivity measurements by flash technique, 20: 823 (LA-DC-7456)
ICC regulations and permits for safe transportation of explosives, 20: 594 (LA-DC-7469)
Line shape measurements on electron cyclotron harmonics emitted by laboratory plasma, 20: 1258 (LA-DC-7364)
Narrow channel flow, 20: 1119 (LA-DC-7357)
Neutron radiography utilizing gadolinium activation foils, 20: 621 (LA-DC-6978)
New technique for remote weighing, 20: 476 (LA-DC-7150)
Precision assay by fission counting, 20: 228 (LA-DC-7439)
Prog. rpt. on advanced reactor technology, 7/65, 20: 1534 (LA-3370)
Remote porosimeter, 20: 622 (LA-DC-7149)

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Application of polarography to biological problems, 20: 44 (COO-1148-98)

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Ultrasonic-induced cavitation studies in lead-bismuth alloy at elevated temperatures, 20: 771 (NP-15558)

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Preliminary results of experiment on the positron g factor, 20: 998 (TID-22255)

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Ratio determination of antimony trisulfide and potassium chlorate by atomic absorption spectrophotometry, 20: 229 (MLM-1289J)

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Dietary intake of ^{226}Ra, 20: 148 (NYO-3086-1, Pt. IV)
Distribution of ^{226}Ra and ^{230}Th in bones of beagle injected with ^{226}Ra, 20: 23 (NYO-3086-1, Pt. III)
Iron-55 in humans, 20: 153 (NYO-3086-1, Pt. X)
Lead-210 content of some selected foods, 20: 149 (NYO-3086-1, Pt. V)
Natural radiation dose to indigenous rodents on the Morro do Ferro, Brazil, 20: 151 (NYO-3086-1, Pt. VII)
Prog. rpt. on radioactivity studies, annual, 12/64–11/65, 20: 146 (NYO-3086-1)
Radioactivity of fossil fuels, 20: 152 (NYO-3086-1, Pt. VIII)
Radiochemical analysis of Brazilian samples from regions of high natural radioactivity, 20: 150 (NYO-3086-1 Pt. VI)
Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1 Pt. I)
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Airborne radioactivity and contamination patterns from transient test of nuclear rocket engine, 20: 565 (CONF-650407, pp 537-56)
Atmospheric diffusion experiments on French nuclear sites, 20: 540 (CONF-650407, pp 394-404)
Atmospheric release limitation techniques in case of reactor accident, 20: 585 (CONF-650407, pp 1000-14)
Atomic and molecular cross sections, 20: 961 (ORNL-3836, pp 67-73)
Brazing flanges to sintered, stainless steel filters for high-temperature service, 20: 786 (ORNL-TM-1252)
Calculating penetration of neutron and γ radiation into underground concrete structures, 20: 1307 (RRA-M45)
Calculation demonstrating effect of $Zr-H_2O$ reaction on analysis of loss-of-coolant accident, 20: 582 (CONF-650407, pp 938-69)
CERL-II. Computer program for analyzing hemisphere-nozzle shells, 20: 459 (ORNL-3817)
Character of effluent material from a transient test of a nuclear rocket engine, 20: 566 (CONF-650407, pp 557-65)
Chemistry of tritium in controlled fusion devices, 20: 1274 (ORNL-3836, pp 111-16)
Comparison of ^{233}U resonance calculation by modified GAM-I, GAM-II and the Hellstrand formulae, 20: 1158 (ORNL-TM-1296)
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Conference on fission product release and transport, Oak Ridge, 4/65, 20: 554 (CONF-650407)
Containment and siting of high power reactors, 20: 1460 (CONF-650407, pp 1015-34)
Critical analysis of the blowdown accident, 20: 570 (CONF-650407, pp 609-40)
DCX-2 beam injection duct, 20: 1276 (ORNL-P-1511)
Deposition of fission-product I on structural surfaces, 20: 574 (CONF-650407, pp 730-46)
Deposition of iodine vapor on surfaces, 20: 215 (CONF-650407, pp 142-77)
Design and engineering—notes, 20: 504 (ORNL-3836, pp 120-9)
Desorption of radioiodine from clays, 20: 600 (ORNL-P-1581)
Development and use of meteorological map overlays for emergency purposes at a power reactor facility, 20: 561 (CONF-650407, pp 439-54)
Development of medium flowrate, high-purity particulate and iodine filters, 20: 589 (CONF-650407, pp 1204-15)
Differential dose albedos for calculation of γ reflection from concrete, 20: 1309 (RRA-T46)
Directory of international workers in atomic and molecular collisions, 20: 1563 (ORNL-AMPIC-2)
Effluent flow in non-stack releases, 20: 562 (CONF-650407, pp 455-9)
Electron-cyclotron heating, 20: 1271 (ORNL-3836, pp 33-5)
Engineering test program to investigate consequences of loss-of-coolant accident, 20: 567 (CONF-650407, pp 567-77)
Examination of Bonus preheater-dryer piping, 20: 1471 (ORNL-TM-1282)
Exploratory experiments concerning the desorption of gases by bombardment with electrons, 20: 915 (ORNL-TM-1166)
Fission gas and I release into coolant systems from defects in UO_2 fuel elements, 20: 555 (CONF-650407, pp 1-37)
Fission product dispersion and release from the SNAPTRAN 2/10A-3 destructive test, 20: 564 (CONF-650407, pp 512-36)
Fission-product deposition in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
Fission product release from coated particle fuels under accident conditions, 20: 556 (CONF-650407, pp 56-72)
Fission product retention and plating behavior in liquid sodium systems, 20: 557 (CONF-650407, pp 73-93)
Fission product release under accident conditions and radiological consequences, 20: 569 (CONF-650407, pp 603-8)
Fission product release program, 20: 571 (CONF-650407, pp 641-7)
Fission product release studies for the EGCR, 20: 581 (CONF-650407, pp 921-37)
Fission product sorption by protective coatings, 20: 573 (CONF-650407, pp 720-9)
Fission product transport in pressure suppression containment, 20: 575

(CONF-650407, pp 753-75)
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Fusion chain reactions, 20: 1275 (ORNL-3836, pp 117-19)
High-current ion-beam production and injection, 20: 962 (ORNL-3836, pp 74-80)
Identity, character, and chemical behavior of vapor forms of radioiodine, 20: 282 (CONF-650407, pp 1131-61)
In-pile fission product release experiments: atmospheric effects, 20: 559 (CONF-650407, pp 276-91)
Influence of activity release and removal effect on escape of fission products from double containment system, 20: 584 (CONF-650407, pp 984-99)
Influence of physical parameters on adsorption of ^{131}I by activated charcoals, 20: 278 (CONF-650407, pp 814-29)
Injection and accumulation—multiple-pass experiments (DCX-2), 20: 1270 (ORNL-3836, pp 15-32)
Injection and accumulation—single-pass experiments (DCX-1), 20: 1269 (ORNL-3836, pp 1-14)
Iodine cleanup in steam suppression system, 20: 576 (CONF-650407, pp 776-804)
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Neutron and γ radiation penetration into concrete-shielded underground structures, 20: 1310 (RRA-T51)
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Plasma theory and computation, 20: 1273 (ORNL-3836, pp 81-9)
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Rapid determination of atmospheric diffusion parameters, 20: 514 (CONF-650407, pp 429-38)
Release of fission products from UO_2 operating at high power rating, 20: 579 (CONF-650407, pp 885-907)
Removal of I and volatile I compounds from air systems by activated charcoal, 20: 280 (CONF-650407, pp 869-84)
Removal of methyl iodide from reactor effluent gases, 20: 279 (CONF-650407, pp 853-68)
Research materials program at ORNL, 20: 287 (ORNL-P-1611)
Sampling and characterization techniques used in study of I release from irradiated fuel elements, 20: 281 (CONF-650407, pp 1096-1109)
Shielding calculations for high-energy accelerators, 20: 935 (ORNL-TM-1298)
Sodium fires and the release characteristics of particulates and fission products, 20: 558 (CONF-650407, pp 94-117)
Some experiments relating to behavior of gas-borne iodine, 20: 578 (CONF-650407, pp 830-52)
Studies of collective electron oscillations in metals by optical methods, 20: 1326 (ORNL-P-1600)
Superheat with boiling alkali metals, 20: 482 (ORNL-P-1659)
Testing of high-efficiency filters for collection of suspended particles, 20: 577 (CONF-650407, pp 805-13)
Theoretical and experimental results useful for estimation of inhalation radiation dose and environmental radioactive contamination, 20: 560 (CONF-650407, pp 362-80)
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Two-step process for decontaminating low-radioactivity-level process waste water, 20: 1549 (ORNL-3811)
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Yield of UN during carbothermic reduction of UO_2 in presence of pure N or N mixed with H_2 or inert gas, 20: 288 (ORNL-TM-1264)

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Fission product sorption by protective coatings, 20: 573 (CONF-650407, pp 720-9)

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Investigation of blast waves from spherical charge using the TNT code, 20: 1350 (TIM-950)
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Hot extrusion of fine plutonium wire, 20: 787 (RFP-623)
Hydrostatic bearing experiments, 20: 461 (RFP-667)
Plutonium excretion following contaminated acid burns and prompt DTPA treatments, 20: 24 (RFP-640)
Plutonium hazards and accident experiences, 20: 154 (RFP-621)
Recovery of plutonium from miscellaneous analytical laboratory wastes, 20: 435 (RFP-551)
Technique for plutonium-electrolytic swab etching, 20: 751 (RFP-543)
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Gas-generating technique for recovering submerged objects, 20: 1567 (SC-RR-65-380)
Highly stable temperature control unit for medium-volume temperature chambers, 20: 625 (SC-TM-65-268)
Mechanical properties of some $PbZrO_3$–$PbTiO_3$ ferroelectrics, 20: 828 (SC-DC-65-1588)
Prog. rpt. on impact effects on spherical shells, 2–4/65, 20: 463 (SC-DC-65-1634)
Re-entry overpressure shock simulation test, 20: 462 (SC-DC-65-1554)
Shock testing with high-explosive-initiated gas detonations, 20: 1566 (SC-DC-65-1545)
SANDIA CORP., LIVERMORE, CALIF.
Fringe counting laser interferometers for industrial length measurement, 20: 626 (SCL-DC-65-92)
SOCIETE BELGE POUR L'INDUSTRIE NUCLEAIRE, BRUSSELS.
Preparation and coating of spherical particles of PuO_2 and $(U–Pu)O_2$ mixtures, 20: 747 (EURAEC-1391)
SOCIETE D'ETUDES, DE RECHERCHES ET D'APPLICATIONS POUR L'INDUSTRIE, BRUSSELS (BELGIUM).
Prog. rpt. on steel corrosion in high-temperature water and steam, 1–3/65, 20: 765 (EURAEC-1387)
Prog. rpt. on steel corrosion in high-temperature water and steam, 4–6/65, 20: 766 (EURAEC-1445)
SOUTHWEST RESEARCH INST., SAN ANTONIO, TEX.
Metallurgical evaluation of the LACBWR forced-circulation clad piping, 20: 788 (SWRI-1228-73)
STAATLICHE ZENTRALE FUER STRAHLENSCHUTZ, BERLIN (EAST GERMANY).
Radiation damage to hematopoietic system. I and II., 20: 64 (SZS-5(1965))
STANFORD LINEAR ACCELERATOR CENTER, STANFORD UNIV., CALIF.
Laser beams. Production of polarized and monochromatic γ radiation, 20: 936 (SLAC-41)
Natural coordinate system for studying vector problems, 20: 938 (SLAC-46)
Prog. rpt. on two-mile accelerator project, 1–3/65, 20: 937 (SLAC-45)
STANFORD RESEARCH INST., MENLO PARK, CALIF.
Interaction of niobium with nitrogen and with oxygen at very low pressures, 20: 775 (SRIA-425-6, pp 10-33)
Prog. rpt. on sorption of gases on metal surfaces in ultrahigh vacuum, 5/15–8/15/65, 20: 916 (SRIA-425-6)
STANFORD UNIV., CALIF. NUCLEAR TECHNOLOGY LAB.
Flow transition phenomena in subsonic plasma jet, 20: 1084 (SU-247-9)
STANFORD UNIV., CALIF. MICROWAVE LAB.
Instability and amplification in finite beam-plasma systems, 20: 1261 (ML-1184)
STATE UNIV. OF NEW YORK, BUFFALO. DEPT. OF BIOLOGY.
Prog. rpt. on radioresistance of microorganisms, 1/1–9/15/65, 20: 6 (NYO-3319-7)
STEVENS INST. OF TECH., HOBOKEN, N. J. DEPT. OF PHYSICS.
Beam-plasma interaction and radiating plasma waves, 20: 1267 (NYO-2813-34)
STOLLER (S. M.) ASSOCIATES, NEW YORK.
Fission product release program, 20: 571 (CONF-650407, pp 641-7)

T

TECHNISCHE HOCHSCHULE, MUNICH (WEST GERMANY). INSTITUT FUER MESS- UND REGELUNGSTECHNIK.
Influence of activity release and removal effect on escape of fission products from double containment system, 20: 584 (CONF-650407, pp 984-99)
TECHNISCHE HOGESCHOOL, DELFT (NETHERLANDS).
Rotating plasma experiment, 20: 1266 (NP-15450)
TECHNISCHE HOGESCHOOL, EINDHOVEN (NETHERLANDS).
Radioactive isotope fueled thermoelectric generators for space missions, 20: 723 (NP-15531)
TECHNISCHER UEBERWACHUNGS-VEREIN RHEINLAND, E. V., COLOGNE (WEST GERMANY).
Theoretical and experimental results useful for estimation of inhalation radiation dose and environmental radioactive contamination, 20: 560 (CONF-650407, pp 362-80)
TENNESSEE UNIV., KNOXVILLE.
Adsorption of n-nonanedecanoic and n-nonadecanoic acids on copper and nickel single crystals, 20: 1570 (TID-22150)
TENNESSEE VALLEY AUTHORITY, OAK RIDGE, TENN.
Fission product release studies for the EGCR, 20: 581 (CONF-650407, pp 921-37)
TEXAS UNIV., AUSTIN.
Current sheath dynamics and magnetosonic oscillations in magneto-plasmas, 20: 1262 (NASA-CR-309)
Kerr cell photography of a dynamical deuterium plasma produced in 30-kilojoule theta pinch, 20: 1255 (ARL-65-171)

TRW EQUIPMENT LABS., THOMPSON RAMO WOOLDRIDGE INC., CLEVELAND, OHIO.
Prog. rpt. on elevated-temperature fatigue data on refractory alloys in ultra-high vacuum, 4–7/65, 20: 824 (NASA-CR-54458)
TURIN UNIV. (ITALY). ISTITUTO DI CLINICA MEDICA GENERALE E TERAPIA MEDICA.
Behavior of DNA synthesis in different phases of S-period in chromosomes of human acute leukemia, 20: 20 (EUR-2451.e)

U

UNION CARBIDE CORP., OAK RIDGE, TENN. Y-12 PLANT.
Applications of spark source mass spectrography to analysis of alloys and pure elements, 20: 235 (Y-KG-28)
UNITED STATES–EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.
Final rpt. on Pu recycle for H_2O-moderated reactors, 8/65, 20: 1436 (GEAP-4907)
Irradiation of 0.5-inch diameter, solid-pellet UO_2 fuel rods at 700,000 Btu/h-ft² peak heat flux, 20: 893 (GEAP-5100A)
Oscillographic polarography of oxygen ions in molten nitrates, 20: 285 (EUR-2496.e)
Preparation and coating of spherical particles of PuO_2 and $(U–Pu)O_2$ mixtures, 20: 747 (EURAEC-1391)
Prog. rpt. on diffusion of rare gases in solids, 4–6/65, 20: 1324 (EURAEC-1428)
Prog. rpt. on reprocessing of irradiated fuels, 10–12/64, 20: 432 (EURAEC-1402)
Prog. rpt. on stainless steel failure, 2–6/65, 20: 767 (GEAP-4915)
Prog. rpt. on steel corrosion in high-temperature water and steam, 1–3/65, 20: 765 (EURAEC-1387)
Prog. rpt. on steel corrosion in high-temperature water and steam, 4–6/65, 20: 766 (EURAEC-1445)
Prog. rpt. on 237-Mw KRB nuclear power plant, 10–12/64, 20: 1475 (TID-22223)
Radiation stability of uranium mononitride, 20: 888 (BMI-1731)
Study of base metal for research on brittle fracture of large welded assemblies, 20: 818 (EURAEC-1348)
UTAH STATE UNIV., LOGAN.
Prog. rpt. on effects of accumulated Ra on productivity of algae, final, 20: 26 (TID-22322)
UTAH UNIV., SALT LAKE CITY. UPPER AIR RESEARCH LAB.
Theory of cylindrical antenna impedance as function of plasma frequency and temperature, 20: 1253 (AFCRL-65-480)

V

VIRGINIA POLYTECHNIC INST., BLACKSBURG. DEPT. OF PHYSICS.
Electrical resistance of cerium as determined by temperature and crystal structure, 20: 829 (TID-22275)
Temperature dependence of the optical reflectivity of cerium metal, 20: 917 (TID-22277)

W

WARSAW UNIV. (POLAND). DEPT. OF RADIOCHEMISTRY.
Neutrinos in superdense matter. II., 20: 951 (NP-15517)
WASHINGTON UNIV., SEATTLE. DEPT. OF ATMOSPHERIC SCIENCES.
Constant temperature wind component meter development and application, 20: 516 (TID-22278)
WEATHER BUREAU, OAK RIDGE, TENN.
Effluent flow in non-stack releases, 20: 562 (CONF-650407, pp 455-9)
WESTINGHOUSE RESEARCH LABS., PITTSBURGH, PA.
Irradiation embrittlement of pressure vessel steels. II., 20: 833 (WERL-8844-5)
WISCONSIN UNIV., MADISON. DEPT. OF PHYSICS.
Prog. rpt. on thermonuclear plasma studies, 5–7/65, 20: 1256 (COO-1233-21)

PERSONAL AUTHOR INDEX

Each entry after an author's name is a shortened version of the title of the report or article, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

A

AALTO, E., Measured and predicted variations in fast neutron spectrum when penetrating laminated Fe–D_2O, 20: 1304 (AE-196)

AALTO, E., Variations in fast neutron spectrum in massive shields of water and concrete, 20: 1318

ABBOTT, A., Controlling furnace cycle with infrared pyrometers in casting uranium ingots, 20: 784 (NLCO-965, pp 3.1-5)

ABECASIS, Sara M., Fast procedure for isolating carrier-free niobium from molybdenum, 20: 262

ABELOVSZKY, Laszlo, Report on the experiences gained during a trip to Poland, 20: 705

ABKIN, A. D., Radiation polymerization of methyl acrylate in ethyl chloride solution, 20: 404

ABKIN, A. D., Radiation polymerization of methyl acrylate in triethylamine and tetrahydrofuran solution, 20: 405

ABKIN, A. D., Radiation polymerization of isobutylene in various solvents, 20: 409

ABKIN, A. D., Radiation polymerization of diketene in solid and liquid states, 20: 398

ABOUL-KHAIR, S. A., Effect of treatment of thyrotoxicosis on exophthalmos, 20: 176

ABRAHAM, L., Magneforming process for fabrication of thin-wall tungsten cylinders, 20: 781 (AI-65-12)

ABRAHAMSSON, Kerstin, Toxin production by Clostridium botulinum in vacuum-packed, irradiated fresh fish, 20: 707

ABRISS, Arnold, Fission-product deposition in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)

ACKLEY, R. D., Identity, character, and chemical behavior of vapor forms of radioiodine, 20: 282 (CONF-650407, pp 1131-61)

ACRES, G. J. K., Irradiation of alumina catalysts, 20: 368

ADAM, Laszlo, Use of radioactive light sources in mine safety, 20: 704

ADAMS, G., Dependence of light scattering by polymer films on polarization angle, and its relationship to randomness of orientation fluctuations, 20: 1572 (TID-22196)

ADAMS, K. H., Impurity effects on basal slip in zinc, 20: 1560 (CALT-473-5)

ADAMS, P. C., Prog. rpt. on environmental monitoring, 1–6/65, 20: 595 (MLM-1275)

ADAMS, R. E., Eight AEC Air-Cleaning Conference, ORNL, 10/63, 20: 518

ADAMS, R. E., Identity, character, and chemical behavior of vapor forms of radioiodine, 20: 282 (CONF-650407, pp 1131-61)

ADAMS, Robert E., Removal of I and volatile I compounds from air systems by activated charcoal, 20: 280 (CONF-650407, pp 869-84)

ADDISON, B. A., Sterilization of surgical sutures: comparison of heat and irradiation, 20: 703

ADELSBERG, Lee Martin, Kinetics of the oxidation of Ta, 20: 780

ADLER, Stephen L., Sum rules for axial-vector coupling-constant renormalization in β decay, 20: 1066

ADRIAN, Lord, Priorities in medical responsibilities, 20: 202

AEBERHARDT, A., Distribution of ^{144}Ce in bone tissue of the rat, 20: 34

AGARWALA, U., Sulfur isotope effects in hydrogen ion decomposition of thiosulfate, 20: 297

AGATI, G., Interpretation of biological effect of radio-chemo therapeutic association in treatment of malignant tumors, 20: 194

AGULLO LOPEZ, F., Nuclear techniques applied to solid-state problems. I., 20: 1166

AKCHURIN, I. A., Theory of elementary particles and information theory, 20: 1051

AKIYAMA, Takashi, Radioactivity in rain water, settled dust, and activated sludge observed in Kagoshima District, 20: 534

ALBRACHT, J., Theoretical and experimental results useful for estimation of inhalation radiation dose and environmental radioactive contamination, 20: 560 (CONF-650407, pp 362-80)

ALBRIGHT, C. H., Weak N* production and SU(6), 20: 1020

ALDERMAN, J. C. Jr., Cosmotron magnetic field measurements, 20: 932 (BNL-9557)

ALEI, Mohammed Jr., Chlorine-oxygen nuclear spin-spin splitting in ClO_2^-, 20: 310

ALEXANIAN, Moorad, Field-theoretic approach to the ρ meson, 20: 1030

ALI, Dolores E., Spins of ^{153}Gd, ^{159}Dy, and ^{148}Pm and hyperfine structures of ^{148}Pm and ^{165}Er, 20: 1248

AL-KHAFAJI, T., Determination of ^{239}Pu content in nuclear fuel by neutron transmission technique, 20: 233 (SGAE-PH-28/1965)

ALLEN, Augustine O., Radiolysis of liquid nitrogen tetroxide, 20: 380

ALLEN, I. B., Plutonium excretion following contaminated acid burns and prompt DTPA treatments, 20: 24 (RFP-640)

ALLEN, J. F., Variable helium film transfer rates down to 0.5°K, 20: 1125

ALLEN, J. F., Velocity fields of helium II carrying a heat current, 20: 1130

ALLEN, R. W., Thin film thermometer as triggering and measuring device in a shock tube, 20: 618 (AWRE-O-58/65)

ALLENDEN, Dennis, Radiation detector and discriminator utilizing semiconductor solid-state detector, 20: 691

ALLISON, G. M., Fission gas and I release into coolant systems from defects in UO_2 fuel elements, 20: 555 (CONF-650407, pp 1-37)

ALLISON, G. M., Release of fission gases and iodines from defected UO_2 fuel elements of different lengths, 20: 890 (EXP-NRX-21406)

ALONSO, A., NUBE—digital code to evaluate hazards of different types of reactor accidents, 20: 587 (CONF-650407, pp 1080-90)

ALSMILLER, R. G. Jr., Shielding calculations for high-energy accelerators, 20: 935 (ORNL-TM-1298)

ALTENBRUNN, H.-J., Pulmonary ventilation after intense irradiation of bronchial carcinomas, 20: 159

ALTMEYER, Georg, Temperature dependence of torsion fatigue strength in tungsten carbide–cobalt alloys, 20: 875

AMBARTSUMYAN, V. A., Problems of modern astronomy and physics of the microworld, 20: 1036

AMIEL, J. L., Prog. rpt. on immunologically competent cells, annual, 1964, 20: 55 (EUR-2469.f)

AMMON, R. v., Solubility of uranium and plutonium in cadmium–zinc–magnesium melts, 20: 447

ANDEEN, Gerry B., Prog. rpt. on two-phase momentum flux and design of a heat pipe, 6/65, 20: 483 (TID-22224)

ANDERSON, A. W., Resistance of microorganisms to ionizing radiation

applied to food, 20: 700 (AD-621921)
ANDERSON, C. J., Investigation of blast waves from spherical charge using the Ax-TNT code, 20: 1350 (TIM-950)
ANDERSON, J. W., Equilibrium temperature for the plutonium α-β transformation, 20: 822 (LA-DC-7278)
ANDERSON, N. G., Prog. rpt. on application of zonal centrifugation in virology and vaccine production, 3–9/65, 20: 7 (ORNL-3883)
ANDERSON, W. A. D., Comparative study of interstitial cell tumors of rat testis induced by cadmium injection and by vascular ligation, 20: 10 (TID-21261)
ANDERSSON-LINDSTROEM, G., Detection of reaction $^{28}Si(n,p)^{28}Al$ in silicon semiconductor detectors at 14 Mev, 20: 1163
ANGELICO, R., Changes in blood lipids in irradiated rats with reference to age and dose, 20: 77
ANSELIN, F., Resistivity and magnetic susceptibility of cerium nitride at low temperature, 20: 1332
ANTON, Nicholas, Superatmospheric pressure ionization chamber for detection of radiant energy, 20: 688
APPLETON, B. R., Axial and planar effects in energy loss of protons in silicon single crystals, 20: 1334
AQUILANTI, Vincenzo, Rare-gas-sensitized radiolysis of methane, 20: 379
ARAKAWA, E. T., Studies of collective electron oscillations in metals by optical methods, 20: 1326 (ORNL-P-1600)
ARGAN, P. E., Photoproduction of π^+ in ^4He and possible existence of an unstable ^4H state, 20: 1210
ARMBRUSTER, P., Mass spectrometric separation of fission products, 20: 434 (JUL-248-NP)
ARNS, R. G., Energy levels of ^{143}Pr, 20: 1199
ARONOV, R. A., Problem of space and time in elementary-particle physics, 20: 1044
ARP, Vincent, Cryogenic aspects of Project Sherwood magnets and magnet materials, 20: 1264 (NBS-8843)
ARTMANN, J., Isentropic expansion of argon plasma in Laval nozzle, 20: 1295
ARTOM, Camillo, Ionizing radiation, atherosclerosis, and lipid metabolism in pigeons, 20: 110
ASCULAI, E., Rapid determination of atmospheric diffusion parameters, 20: 514 (CONF-650407, pp 429-38)
ASHWORTH, C. P., Fission product transport in pressure suppression containment, 20: 575 (CONF-650407, pp 753-75)
ASSOVSKAYA, A. S., Interaction of 7.2-Bev/c π^- mesons with nuclei, 20: 1224
ASTLEY, Eugene R., Fast fuel test reactor, 20: 1546
ATHERTON, David R., Thorium-228 decay series in adult beagles: ^{224}Ra, ^{212}Pb, and ^{212}Bi in blood and excreta, 20: 42
ATTERBURY, T. J., Prog. rpt. on analysis of information on reinforced openings in pressure vessels, 2/63–2/64, 20: 457 (BMI-X-276)
ATTREE, P. M., FREAK: A G-20 computer program for making frequency distribution tables, 20: 733 (CRT-1167)
ATTREE, P. M., Survey of values of the 2200 m/s constants for four fissile nuclides, 20: 1164
ATTRILL, J. E., Identity, character, and chemical behavior of vapor forms of radioiodine, 20: 282 (CONF-650407, pp 1131-61)
AUGENSTEIN, Leroy, Inactivation of enzymes by uv light. V., 20: 51
AUNG, Tin, Optical spectroscopy of radioactive mercury and thallium isotopes, 20: 1245
AUSLOOS, P., Gas-phase radiolysis and photolysis of neopentane, 20: 369
AXTMANN, Robert C., Energy loss by fission fragments in nitrogen, 20: 387

B

BADAREU, E., Hollow-cathode effect in cesium vapor, 20: 1087
BAECHMANN, K., Homogeneous redox reactions in sulfate-ion-containing solutions. III., 20: 296
BAEHR, Werner, Method for pre-decontamination of nuclear fuel to be reprocessed, 20: 452
BAEHR, Werner, Method of reprocessing irradiated nuclear fuel, 20: 455
BAERNIGHAUSEN, H., Preparation and crystal structure of samarium, europium, and ytterbium oxide bromides LnOBr and Ln_3O_4Br, 20: 869
BAHL, K. L., Autoradiography of fuel elements of the Kiwi reactor, 20: 1438
BAIER, V. N., Photon emission in electromagnetic annihilation of heavy particles, 20: 1024
BAIRD, R. C., Interactions of 14.6-Mev neutrons in iron, ^7Li, and carbon, 20: 1144 (AD-614451)
BAKER, Louis Jr., Calculation demonstrating effect of $Zr-H_2O$ reaction on analysis of loss-of-coolant accident, 20: 582 (CONF-650407, pp 938-69)
BALANDIN, A. A., Isotopic exchange of cyclobutane with deuterium on evaporated metal films, 20: 304
BALDIN, A. M., Excited level 0^+ in ^4He nucleus. Mirages, 20: 1221
BALDUS, Wolfgang, Process and means for removing radioactive components from gases and gaseous mixtures, 20: 1397
BALODIS, M. K., Conversion electrons emitted in reaction $^{169}Tm(n,\gamma)^{170}Tm$, 20: 1223
BANASCHAK, A., Experiences with high-energy radiation at cancer clinic, 20: 205
BANKOFF, S. G., Bubble dynamics in boiling, 20: 489
BANKS, Charles V., Tri-n-octylphosphine sulfide: a selective organic extractant, 20: 244
BANKS, D. C., Preshot investigations for project Pre-Schooner, Buckboard Mesa, Nevada Test Site, 20: 511 (PNE-505P)
BANSAL, R. K., Multipole sum rules for single-nucleon-transfer spectroscopy, 20: 1190
BARBER, J. A., Comparison of heat-flux sensors using thermal radiation sources, 20: 624 (SC-DC-65-1507)
BARNES, B. K., Level assignments in ^{17}O from $^{13}C(\alpha,\alpha)^{13}C$ and $^{13}C(\alpha,n)^{16}O$, 20: 1212
BARNES, Hale, Control systems for nuclear reactors, 20: 1407
BARNES, John F., Quantum- and correlation-corrected Thomas-Fermi-Dirac equation, 20: 972
BARNETT, C. F., Atomic and molecular cross sections, 20: 961 (ORNL-3836, pp 67-73)
BARNETT, James, Gamma attenuation by loblolly pine wood, 20: 1313
BAROCZY, C. J., Systematic correlation for two-phase pressure drop, 20: 491
BARR, Frank T., Apparatus for producing heat and power by the application of nuclear fission, 20: 1521
BARR, Harold N., Liquid fluidized bed nuclear reactor and method for reducing particle abrasion therein, 20: 1428
BARRADA, Y., Neutron moisture meter and its value in water-use efficiency studies, 20: 544
BARSUKOV, V. S., Post-radiational regeneration of yeast cells during stationary phase of growth, 20: 79
BARTHOUX, A., French safety research program on fission product behavior, 20: 568 (CONF-650407, pp 578-86)
BARUT, A. O., Non-compact groups. I., 20: 738
BARUT, A. O., Non-compact groups. II., 20: 739
BASERGA, Renato, Tumor induction in mice by radioactive thymidine, 20: 66 (TID-22292)
BASL, G. J., Film thickness measurement by x-ray emission and β backscatter techniques, 20: 493
BASSEL, R. H., Polarization studies at the Oak Ridge isochronous cyclotron, 20: 1157 (ORNL-P-1616)
BATE, L. C., Trace elements in human hair, 20: 268
BATTLES, James Everett, Mass-spectrometric investigation of tungsten trioxide, 20: 881
BATZER, T. H., Practical vacuum techniques, 20: 508
BATZER, Thomas H., Aluminum foil ultrahigh vacuum gasket seal, 20: 468
BAUER, R. F., Induction and salt heat treating of solid and hollow oil-quenched HAPO core blanks, 20: 785 (NLCO-965, pp 5.1-10)
BAUER, W., Influence of impurities on the recovery of electron-irradiated gold, 20: 900
BAVETTA, L. A., Localized γ irradiation from ^{60}Co on synthesis of collagen by subcutaneous granulomas, 20: 52
BAZHANOV, E. B., Photoneutron cross section of ^{12}C, 20: 1196
BEADLE, Charles W., Moire fringe method for strain analysis, 20: 1574 (UCRL-13156)
BEAL, Jack William, Beam deflection for three-sector cyclotron, 20: 944
BECCHI, C., Test of nonrelativistic quark model for elementary particles, 20: 1016
BECK, Clifford K., Power reactor accidents in perspective, 20: 580 (CONF-650407, pp 908-20)
BECKER, H., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
BECKER, H.-D., Comparison of effect of mitomen and x rays on ascites cells of Ehrlich carcinoma in mice, 20: 118
BECKER, K., Neutron dosimetry with Ag-activated phosphate glasses, 20: 628
BECKER, Melvin H., Management of Hodgkin's disease coexistent with pregnancy, 20: 209
BECKER, W., Experimental results on dynamics of the F region, 20: 1099
BEDE, Gabor, Improved reactors, 20: 1486
BEDNAR, J., Degradation spectrum of electrons, electronic excitation spectra of molecules, and primary radiation chemical yield, 20: 365
BEER, B. J., Hot extrusion of fine plutonium wire, 20: 787 (RFP-623)
BEGHI, G., Maintenance of properties of SAP after treatment of fusion of the matrix, 20: 842
BEHLKE, H., Anode region of delayed glow discharge in oxygen, 20: 1088
BEHLKE, H., Behavior of electrons in stratified low-pressure discharge, 20: 1086
BEIERWALTES, William H., Treatment of malignant disease of thyroid, 20: 196
BEISSNER, R. E., Formulation of radiation transport solutions for shielding

applications, 20: 1303 (AD-614250)
BELL, F., Angular dependence of electron-penetration in monocrystalline copper, 20: 1331
BELL, Francis R., Gas-cooled reactor with improved coolant flow path arrangement and fuel assembly therefor, 20: 1435
BELL, P. R., DCX-2 beam injection duct, 20: 1276 (ORNL-P-1511)
BELL, P. R., Injection and accumulation—multiple-pass experiments (DCX-2), 20: 1270 (ORNL-3836, pp 15-32)
BELOTE, T. A., Level assignments in ^{17}O from $^{13}C(\alpha,\alpha)^{13}C$ and $^{13}C(\alpha,n)^{16}O$, 20: 1212
BENCZER-KOLLER, N., Magnetic moment of 99-kev first excited state of ^{195}Pt, 20: 1202
BENEDICT, Glen E., Electrolytic separation of plutonium values from uranium values, 20: 456
BENNETT, M. R., Fused-salt fluoride-volatility process for recovering uranium from spent aluminum-based fuel elements, 20: 442
BENNETT, S., Experimental performance of high specific impulse arc-jet engine, 20: 500
BEONE, G., Aluminum and aluminum–uranium alloy plates dissolution in acid and acid-deficient conditions. I., 20: 438 (RT/CHI(65)23)
BERENDS, F. A., Lifetime of the η meson, 20: 1005
BERESTETSKII, V. B., Certain aspects of contemporary development of elementary particle theory, 20: 1034
BERGER, K.-H., Test measurements by means of scintiscanner contrast amplifier, 20: 662
BERGMAN, Sten G. A., Design of protective construction in hard rock, 20: 496
BERGNER, K. G., Radioactivity measurements in foodstuffs. II., 20: 524
BERGQVIST, I., Fast-neutron-capture γ spectrum from $^{238}U(n,\gamma)^{239}U$, 20: 1168
BERGSNOV-HANSEN, B., Prog. rpt. on sorption of gases on metal surfaces in ultrahigh vacuum, 20: 916 (SRIA-425-6)
BERK, Harold, Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1, Pt. I)
BERK, Herbert Lester, Electrical transport equation for a plasma model, 20: 1302
BERKNER, Klaus H., Electron capture by high-energy deuterons in gases, 20: 974
BERLINER, David L., Serum lactic dehydrogenase levels in adult beagle dogs with internally deposited radionuclides, 20: 112
BERMAN, B. L., Photoneutron cross sections of ^{6}Li, 20: 1217
BERNARDELLI, R., Behavior of DNA synthesis in different phases of S-period in chromosomes of human acute leukemia, 20: 20 (EUR-2451.e)
BERNER, C. W., CEP. Monto Carlo program for the calculation of first-flight escape probabilities for finite cylinders, 20: 1133 (IDO-17075)
BERNIER, Gilles, Radiopelvimetry by Swedish method, 20: 187
BERNSTEIN, S., Testing of ten-ton UF_6 cylinders, 20: 593 (KY-500)
BERTSCH, George F., Role of core polarization in two-body interaction, 20: 1186
BETTERTON, Jesse Ostman Jr., Method of increasing critical current density of hard superconducting alloys and the products thereof, 20: 1121 (Al-Trans-97)
BEUTNER, H. P., Isotopes in industry. Trends in industrial use of radioisotopes and ionizing radiation, 20: 702 (NYO-3337-16)
BEYER, Norman S., Quality evaluation of CP-5 reactor fuel, 20: 1533 (CONF-650532-2)
BHATNAGAR, P. L., Transport processes in multi-component assembly on basis of generalized BGK collision model, 20: 1090
BIERMANN, Wendell Josef, Method for extraction of beryllium oxide from beryllium-containing ores, 20: 453
BIGHAM, C. B., Measurement of fast fission ratios in natural uranium, 20: 1147 (CRRP-1220)
BILDSTEIN, H., Production of small uranium carbide spheres from melts and melt suspensions, 20: 792
BILLARD, F., Atmospheric release limitation techniques in case of reactor accident, 20: 585 (CONF-650407, pp 1000-14)
BILLARD, F., Influence of physical parameters on adsorption of ^{131}I by activated charcoals, 20: 278 (CONF-650407, pp 814-29)
BINGHAM, W. G. Jr., Low-activation shielding materials for reactor environmental test chambers, 20: 478
BIRABEN-SCOTT, Betsy, Fast procedure for isolating carrier-free niobium from molybdenum, 20: 262
BISHOP, Paul A., Radiologic studies of the gravid uterus, 20: 214
BISTOLFI, F., Early and late effects in clinical radiotherapy, 20: 204
BKHARGAVA, Kh. D., New compounds of rare earths with strontium and barium oxides, 20: 302
BLACKETT, N. M., Effect of radiation on the parent to F_1 hybrid graft-versus-host reaction, 20: 86
BLAIR, A. G., Reaction $^{62,64}Ni(^{3}He,d)^{63,65}Cu$, 20: 1216
BLAISE, Michele, Vapor pressures of metals and refractory metalloids. II., 20: 331
BLAKE, C. A. Jr., Prog. rpt. on chemical applications of nuclear explosions, 7–9/65, 20: 469 (ORNL-TM-1275)
BLANKENSHIP, J. L., Method for producing p-i-n semiconductors, 20: 1580
BLANKS, B. L., Neutron radiography utilizing gadolinium activation foils, 20: 621 (LA-DC-6978)
BLAUGHER, R. D., Magnetic instabilities and flux annihilation in grossly inhomogeneous superconductors, 20: 1132
BLINC, R., Dielectric properties of partially deuterated $NaH_3(SeO_3)_2$ single crystals, 20: 1333
BLOCK, Linda, Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1, Pt. I)
BLOKHINTSEV, D. I., Problems of structure of elementary particles, 20: 1037
BLOOD, Frank Alden Jr., Pair correlation functions in classical statistical mechanics, 20: 1082 (COO-720-053)
BLUMBERG, L. N., Polarization studies at the Oak Ridge isochronous cyclotron, 20: 1157 (ORNL-P-1616)
BOAG, J. W., Action of ionizing radiation on dilute aqueous solutions, 20: 390
BOBTELSKY, M., Microheterometric method for determination of vanadium, 20: 257
BOCHKAREV, V. A., Separation of Am and Cm by anion exchange, 20: 439 (ORNL-tr-893)
BODDY, Keith, Radiation detector and discriminator utilizing semiconductor solid-state detector, 20: 691
BOERNER, Gudrun, Metallographic preparation of nuclear fuel particles, 20: 797
BOETTCHER, B., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
BOLD, F., Final safety and hazards report for the SNAP-15A generator, 20: 722 (GA-4554(Rev.))
BOLLER, Ernest R., Canning machine, 20: 805
BOLTA, J. M., Magnetic analysis of the $^{51}V(d,p)^{52}V$ reaction, 20: 1167
BONE, L. I., Effects of temperature in radiolysis of methane and propane, 20: 381
BONFER, D. C., Use of cut-crown magnesium in production of uranium metal, 20: 749 (NLCO-965, pp 1.1-5)
BONNER, Norman A., Radioactivity: distribution from cratering in basalt, 20: 613
BOOT, S. J., Reduction of sulfur dose threshold in the AERE criticality dosimeter, 20: 647 (AERE-M-1631)
BOOT, S. J., Slow neutron calibration of film and other γ dosimeters, 20: 648 (AERE-R-4960)
BORCHARDT, Hans J., Hydration of rare-earth tungstates, 20: 307
BORDONALI, C., Influence of the organic Cl content in terpheayl on Fe corrosion and transport, 20: 777
BORELLA, H. M., Aerial radiological monitoring system, 20: 520 (CEX-59.4(Pt.3))
BOROWSKI, Feliks, Slow neutron scattering by CH_3OH and CH_3SH molecules, 20: 325
BORYSOWICZ, J., Diffraction scattering of deuterons on non-spherical nuclei, 20: 1153 (INR-605/VII/PL)
BOSSHARD, Ernst, Method of replacing fuel elements in nuclear reactor, 20: 1401
BOTELLA-LLUSIA, Jose, Pelvic lymph nodes in carcinoma of uterine cervix before and after deep x irradiation, 20: 212
BOUDOURESQUES, Bernard, Fuel element for nuclear reactor, 20: 1443
BOWEN, H. C., Corrosion evaluation of high-silicon aluminum alloys, 20: 763 (BNWL-125)
BOYLE, T. J., Magnetic moments and vehicle torques in the SNAP 10A, 20: 1528 (NAA-SR-11207)
BOZDUGANOV, A., Investigations of chronic γ irradiation of heart, liver, and kidneys, 20: 102
BRADY, D. N., Hanford mobile whole-body counter, 20: 660
BRAEYEN5, W., Conservation and stability of labeled macromolecules, 20: 2 (EUR-2419.f)
BRAMBLETT, R. L., Photoneutron cross sections of ^{6}Li, 20: 1217
BRANDON, George W., Heat-shield ablation and sublimation determinations through radioisotope techniques, 20: 720
BRANDY, J. H., Temperature curve for upper atmosphere from 80 to 160 km, 20: 1096
BRAUER, G., Preparation and crystal structure of samarium, europium, and ytterbium oxide bromides LnOBr and Ln_3O_4Br, 20: 869
BREBANT, C., Possibilities offered by γ spectrometry in nondestructive measurements on fuel elements, 20: 236 (AEC-tr-6621)
BRESSER, H., Theoretical and experimental results useful for estimation of inhalation radiation dose and environmental radioactive contamination, 20: 560 (CONF-650407, pp 362-80)
BREWEN, J. G., Cell cycle and radiosensitivity of chromosomes of human leukocytes, 20: 88
BREWER, Leo, Prediction of high-temperature metallic phase diagrams, 20: 882
BREZIN, C., Prog. rpt. on immunologically competent cells, annual, 1964,

20: 55 (EUR-2469.f)
BRIGGS, D. C., Nickel-rich alloys of Ni–Hf–C and Ni–Zr–C systems, 20: 826 (NP-15535)
BRIGGS, G. G., Use of cut-crown magnesium in production of uranium metal, 20: 749 (NLCO-965, pp 1.1-5)
BRIGNOCCHI, A., Influence of the organic Cl content in terphenyl on Fe corrosion and transport, 20: 777
BRIMHALL, J. L., Combined effect of carbon and neutron radiation on molybdenum, 20: 895
BRINKSCHULTE, Hermann, Production of short single pulses in high-current discharges, 20: 1095
BRISSE, Francois, Determination of crystal structure of $Er_2Ti_2O_7$ by x-ray and neutron diffraction, 20: 298
BRITE, Daniel W., Fabrication of shapes by pneumatic impaction, 20: 809
BROCKMAN, K. W. Jr., Proton spectra from d + d breakup at 25.3 Mev, 20: 1172
BRODE, Harold L., Design of underground protective structures, 20: 495
BRODI, G., Controlling furnace cycle with infrared pyrometers in casting uranium ingots, 20: 784 (NLCO-965, pp 3.1-5)
BROECKER, Wallace S., Radiocarbon chronology of Lake Lahontan and Lake Bonneville II, Great Basin, 20: 546
BRONIKOWSKI, Thomas Andrew, Systems of integrodifferential equations occurring in reactor dynamics, 20: 1420
BROQUET, C., Checking wear of refractories by radioactive inserts, 20: 715
BROSIG, W., Clinical problems of kidney transplantation in humans, 20: 125
BROSSA, F., Vanadium as diffusion barrier between aluminum and uranium, 20: 855
BROSZKIEWICZ, Romen, Radiation-induced oxidation and reduction reactions of Fe in aqueous solutions. IX., 20: 388
BROWMAN, A., Scattering of 150- and 300-Mev positrons and electrons from bismuth, 20: 913 (LAL-1142)
BROWN, E. A., Effect of nitric acid etching on nitrogen and carbon analysis of uranium metal, 20: 230 (NLCO-965, pp 4.1-5)
BROWN, G. E., Collective motion in light nuclei, 20: 1227
BROWN, J. L., K^* production in $K^+ + n$ and $K^+ + p$ reactions, 20: 1010
BROWN, James Robert, Monitoring and warning apparatus for contaminations effected by α and β rays, 20: 679
BROWN, John L., K^+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
BROWN, K. B., Prog. rpt. on chemical applications of nuclear explosions, 7–9/65, 20: 469 (ORNL-TM-1275)
BROWN, R. L., DCX-2 beam injection duct, 20: 1276 (ORNL-P-1511)
BROWN, T. A., Existence and uniqueness of solution to problem in invariant imbedding, 20: 1315
BROWN, W. Lynn, Sex as factor in position-postremity responses of Rhesus monkeys, 20: 92
BROWNING, W. E. Jr., Deposition of fission-product I on structural surfaces, 20: 574 (CONF-650407, pp 730-46)
BROWNING, W. E. Jr., Identity, character, and chemical behavior of vapor forms of radioiodine, 20: 282 (CONF-650407, pp 1131-61)
BROWNING, W. E. Jr., In-pile fission product release experiments: atmospheric effects, 20: 559 (CONF-650407, pp 276-91)
BROWNING, William E. Jr., Removal of I and volatile I compounds from air systems by activated charcoal, 20: 280 (CONF-650407, pp 869-84)
BRUBAKER, C. H. Jr., Effect of tartaric acid on kinetics of oxidation of uranium(IV) by thallium(III) in aqueous perchloric acid, 20: 319
BRUCE, Alan K., Prog. rpt. on radioresistance of microorganisms, 1/1–9/15/65, 20: 6 (NYO-3319-7)
BRUCKER, W., Effect of chronic irradiation with low dose rate on plants and their photoreactivability, 20: 120
BRUECK, A., Determination of lutetium in Al–Lu alloy, 20: 247
BRUNNER, H. E., Risk of leukemia by irradiation, 20: 161
BRUNNER, W. F. Jr., Practical vacuum techniques, 20: 508
BRUNST, V. V., Response of cornea of adult axolotl to x radiation, 20: 82
BRYANT, Paul J., Residual-gas analysis of oil-diffusion-pumped uhv system, 20: 506
BRYCE, Donald H., Rossi-α experiment, 20: 1419
BRYNSVOLD, Glen V., Continuous-support fuel rod spacer system, 20: 1409
BUBEN, N. Ya., Study of polymer mixture by radiothermoluminescence, 20: 366
BUCCINO, S. G., Levels in ^{10}B excited by the $^{9}Be(d,n)$ reaction, 20: 1194
BUCHANAN, J. R., Action on reactor projects undergoing regulatory review, 20: 1509
BUCHANAN, J. R., Changes in licensing regulations, 20: 1510
BUCHBINDER, Goetz G. R., PcP from nuclear explosion Bilby, September 13, 1963, 20: 545
BUCHER, E., Density of states of chromium and its alloys, 20: 1330
BUCKINGHAM, J. S., Plant-scale demonstration of promethium recovery and purification processes, 20: 1551 (RL-SA-53)
BUDDENBAUM, Warren Edward, Substituent effects on secondary deuterium isotope rate effects, 20: 336
BUDDERY, J. H., Conversion of irradiated fuel swarf to stable ceramic suitable for long-term storage, 20: 1554
BUECHI, J., Influence of radioactive rays on pharmaceuticals. III., 20: 713
BUEKI, Imre, Power stations with gas–graphite reactors, 20: 1482
BUFORD, William H. Jr., Development of γ radioisotope thrustor, 20: 724
BUNCH, D. F., Measurement of released fission products from a nuclear excursion, 20: 563 (CONF-650407, pp 497-511)
BURCH, R. F., Thin film thermometer as triggering and measuring device in a shock tube, 20: 618 (AWRE-O-58/65)
BURGETT, R., Prog. rpt., 7–9/65, 20: 748 (NLCO-965)
BURIANEK, J., Rapid determination of radiochemical purity of orthophosphate ^{32}P, 20: 271
BURLEIGH, Richard J., Absorption of energy by rotating discs in particle beam deflector, 20: 950
BURNS, B., Zero-gravity radiotracer propellant gage, 20: 721
BURSON, S. B., Decay of ^{129}Cs, 20: 1200
BURTSCHER, A., Operating Compton spectrometer, 20: 1440
BURUIANA, L. M., Effects of radiation on proteins. VI., 20: 67
BUSCAGLIONE, S., Buildup factors for concrete: coefficients of the polynomial representation, 20: 1311 (RT/FIMA(65)2)
BUSTER, Dawn S., Thorium-228 decay series in adult beagles: ^{224}Ra, ^{212}Pb, and ^{212}Bi in blood and excreta, 20: 42
BUTTERWORTH, I., K^* production in $K^+ + n$ and $K^+ + p$ reactions, 20: 1010
BUTTERWORTH, IAN, K^+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
BUXTON, G. V., Radical and molecular yields in γ-radiolysis of water. II., 20: 392
BUZZELLI, George, Microdetermination of ^{235}U in irradiated graphite fuel systems, 20: 241

C

CADENA, D. G., Energy dependence of free radical production in alanine, 20: 394
CAGNETTA, J. P., Fission product release program, 20: 571 (CONF-650407, pp 641-7)
CAIRNCROSS, A., Anomalous deuterium hyperfine splittings, 20: 315
CALDWELL, J. T., Photoneutron cross sections of ^{6}Li, 20: 1217
CAMAHORT, J., High-temperature chemical engineering research in nuclear technology, 20: 292 (UCRL-16173)
CAMPANA, R. J., Final safety and hazards report for the SNAP-15A generator, 20: 722 (GA-4554(Rev.))
CAMPBELL, Milton H., Analysis for microgram quantities of thorium in plutonium, neptunium, and uranyl nitrate solutions, 20: 242
CAMPBELL, Ronald Hugh, Control systems for nuclear reactors, 20: 1407
CAMPBELL, Ronald Hugh, Nuclear reactor core, 20: 1434
CANDES, P., French safety research program on fission product behavior, 20: 568 (CONF-650407, pp 578-86)
CANET, Pierre, Machines for loading and unloading channels of nuclear reactor, 20: 1402
CANO, Gilbert Lucero, Alpha disintegrations in surface deposits of ^{210}Po and ^{241}Am, 20: 426
CARAZZOLO, G., Relative orientation of the twinned polythiomethylene crystals from trithiane by γ irradiation, 20: 353
CARLONI, G., Optika 2—a program for magnetic channel design, 20: 934 (ISS-65/4)
CARLSON, O. N., Pneumatic-mechanical high-energy-rate extrusion of yttrium, 20: 783 (IS-1227)
CARO, Paul, Vapor pressures of metals and refractory metalloids. II., 20: 331
CARON, J., Influence of physical parameters on adsorption of ^{131}I by activated charcoals, 20: 278 (CONF-650407, pp 814-29)
CARP, Richard I., Influence of D_2O on plaque size of western equine encephalitis virus, 20: 39
CARTER, D., Dispersion relation and frequency characteristics of alternating periodic structure for linear accelerators, 20: 931 (BNL-9554)
CASEY, K. F., Cherenkov radiation in inhomogeneous periodic media, 20: 979
CASLEY-SMITH, John R., Endothelial permeability— the passage of particles into and out of diaphragmatic lymphatics, 20: 16
CASPARINI, G., Changes in blood lipids in irradiated rats with reference to age and dose, 20: 77
CASSIE, G. E., Determination of plutonium by potentiometric titration, 20: 222 (AERE-R-4975)
CASTAGNET, Antonio C., Measurement of density by gamma scattering, 20: 623 (NP-15529)
CASTELLIZ, Lotte, Determination of crystal structure of $Er_2Ti_2O_7$ by x-ray and neutron diffraction, 20: 298
CASTORINA, Thomas C., Radiolysis of liquid nitrogen tetroxide, 20: 380
CATALA, J., Magnetic analysis of the $^{51}V(d,p)^{52}V$ reaction, 20: 1167
CATHERS, G. I., Fused-salt fluoride-volatility process for recovering uranium from spent aluminum-based fuel elements, 20: 442
CAVALLARO, L., Stress analysis of rotating disks, 20: 467

CAVINA, G., Changes in blood lipids in irradiated rats with reference to age and dose, 20: 77
CELLI, V., Ground state of an electron gas in a magnetic field, 20: 921
CERESARA, S., Recovery of Al–Si alloys neutron irradiated at 78°K, 20: 905
CERNY, Joseph, Reactions (d,α) on ^{12}C, ^{14}N, and ^{16}O induced by 24-Mev deuterons, 20: 1211
CERRAI, E., Strontium-90 in upper layers of coastal sediments of the Ligurian Sea, 20: 526
CESARANO, C., Uranium and fission products release from uranium dioxide, 20: 894 (RT/CHI(65)27)
CESARI, F., Instrumented fuel element for the PRO reactor, 20: 1472 (RT/ING(64)12)
CESARI, F., Instrumented fuel element for the PRO reactor (enclosures), 20: 1473 (RT/ING(64)12bis)
CHA, Moon H., Polarization of a decay particle in a two-step process, 20: 1013
CHALLENDER, Rosald Scott, Nuclear reactor core, 20: 1434
CHALMERS, J. H., Handbook of criticality data. I., 20: 1410 (AHSB(S) HANDBOOK-1(1st.Rev.))
CHAMBERS, R. H., Prog. rpt. on mechanical properties of reactor materials, 2–4/65, 20: 819 (GA-6413)
CHANDRA, G., Lifetimes of positronium in polyethylene irradiated by γ rays, 20: 1002
CHAPMAN, A. T., Growth of UO_2 single crystals using the floating-zone technique, 20: 758
CHARALAMBUS, S., Enrichment of tritium by diffusion through palladium, 20: 272
CHARLES, P., Conservation and stability of labeled macromolecules, 20: 2 (EUR-2419.f)
CHARLESBY, A., Protection of aqueous polymer solutions by colloidal sulfur, 20: 137
CHELTON, D. B., Cryogenic aspects of Project Sherwood magnet refrigeration, 20: 1265 (NBS-8846)
CHEN, H. C., Dyadic Green's function for magnetic current source in compressible anisotropic plasma, 20: 1283
CHEN, Ru-yong, Cell model for quantum fluids. III., 20: 1089
CHENG, D. K., Dyadic Green's function for magnetic current source in compressible anisotropic plasma, 20: 1283
CHEON, Il-T., Absorption of stopped π^- mesons by ^{12}C nuclei, 20: 1193
CHEPURCHENKO, I. A., Investigation of the $^3He + {}^3He$ reaction, 20: 1154 (JINR-P-2323)
CHERKASOVA, L. S., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
CHERNICK, Jack, Safety considerations based on design experiences in BNL settled-bed fast reactor concept, 20: 1456 (BNL-9475)
CHEVALIER, G., Influence of physical parameters on adsorption of ^{131}I by activated charcoals, 20: 278 (CONF-650407, pp 814-29)
CHIKISHEV, Yu. G., Mechanism of radiation polymerization of diphenylvinylphosphine oxide, 20: 408
CHIKISHEV, Yu. G., Radiation polymerization of diphenylvinylphosphine in solid state, 20: 399
CHILDERS, Melvin D. Jr., Increased granuloma formation from absorbable sutures, 20: 712
CHIRKOV, V. P., Determination of water supplies in snow deposits by aerial γ exposure, 20: 549
CHOQUET, C., Prog. rpt. on immunologically competent cells, annual, 1964, 20: 55 (EUR-2469.f)
CHOUDHURY, S. Rai, Role of baryon exchanges in generating $\frac{1}{2}^+$ resonances, 20: 1014
CHRISTENBERRY, Kenneth W., Recording lens opacities, 20: 75
CHRISTENSEN, Ebbe Ahrensburg, Radiation resistance of substrains from Streptococcus faecium, 20: 69
CHRISTIAN, J. W., Effect of high vacuum purification on niobium single crystals, 20: 838
CHRISTIANSON, Charles, Beta and γ measuring apparatus for fluids, 20: 685
CHU, E. L., Natural coordinate system for studying vector problems, 20: 938 (SLAC-46)
CHU, William T., Kinematics of Λ-hyperon β decay, 20: 1015
CHUKICHEV, E. M., Effects produced by sodium nicotinate, riboflavin, and folic acid on phagocytosis during x-ray treatment of patients with malignant new growths, 20: 191
CHURCHILL-DAVIDSON, I., High-pressure oxygen and radiotherapy, 20: 170
CHWASZCZAEWSKA, Janina, Gold–silicon surface-barrier β spectrometer with multi-gard-ring, 20: 665
CHWASZCZEWSKA, Janina, Lithium-drifted detectors for β and γ spectrometry, 20: 664
CHWOJNIK, A., Use of ^{99m}Tc in hepatic scintillography, 20: 197
CIESLAK, E., Observation of fission events in mica sandsiches, 20: 652 (INR-647/I-A,VI/PH)
CIFKA, J., Rapid determination of radiochemical purity of orthophosphate ^{32}P, 20: 271
CINI, M., Meson-baryon scattering as test of colinear hybrid group SU(6), 20: 1006
CINOTTI, G. A., Effects of osmotic diuresis on renal clearance of ^{85}Sr and ^{45}Ca in the dog, 20: 30
CLAPPER, William E., Susceptibility of tissue cultures of canine origin to viruses, 20: 4 (LF-26)
CLARK, G. W., Growth of UO_2 single crystals using the floating-zone technique, 20: 758
CLARK, H. K., Simple, practical method for calculating interaction, 20: 590 (CONF-651103-5)
CLARKSON, Thomas B., Ionizing radiation, atherosclerosis, and lipid metabolism in pigeons, 20: 110
CLAUSING, R. E., Exploratory experiments concerning desorption of gases by bombardment with electrons, 20: 915 (ORNL-TM-1166)
CLAY, Douglas R., Muon capture in ^3He, 20: 1209
CLELAND, J. W., The research materials program at ORNL, 20: 287 (ORNL-P-1611)
CLINARD, F. W., Effects of dilute rare-earth additions on electrical conductivity of cerium at low temperatures, 20: 864
CLINE, G. B., Prog. rpt. on application of zonal centrifugation in virology and vaccine production, 3–9/65, 20: 7 (ORNL-3883)
CLOUGH, W. S., Radioiodine adsorption on particulate matter, 20: 216 (CONF-650407, pp 242-75)
COATES, R. L., Computation of potential radiological hazards from reactor accidents, 20: 1348 (CONF-650407, pp 1057-70)
COBB, James C., Gallium concentrations in metal phases of various meteorites, 20: 530
COBLE, R. L., Deformation behavior of refractory compounds, 20: 886
COCKRELL, Robert G., Kinetic theory of spatial and spectral coupling of reactor neutron field, 20: 1411 (CONF-650413-13)
COHEN, Bernard L., Introduction to stripping, 20: 1228
COHEN, E. Richard, Fundamental constants of physics and chemistry in 1965, 20: 922
COHEN, Karl, Apparatus for producing heat and power by the application of nuclear fission, 20: 1521
COHEN, N., Analytical development, 20: 417 (NYO-3086-1, Pt.IX)
COHEN, Norman, Radiochemical analysis of Brazilian samples from regions of high natural radioactivity, 20: 150 (NYO-3086-1, Pt.VI)
COHEN, Norman, Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1, Pt. I)
COJOCARU, V., Gamma-gamma angular correlation measurements of thermal-neutron-capture γ rays in ^{200}Hg, 20: 1152 (IFA-RN-21)
COLEGROVE, Forrest D. Jr., Atomic-collision-influenced gaseous ^3He quantum resonance magnetometer apparatus, 20: 642
COLEMAN, C. E., Slow-bend testing of hydrided zirconium, 20: 857
COLLIER, R. S., Cryogenic aspects of Project Sherwood magnets and magnet materials, 20: 1264 (NBS-8843)
COLLINS, Clair J., Isotopes and organic reaction mechanisms, 20: 348
COLLINS, D. A., Removal of methyl iodide from reactor effluent gases, 20: 279 (CONF-650407, pp 853-68)
COLLINS, D. A., Sampling and characterization techniques used in study of I release from irradiated fuel elements, 20: 281 (CONF-650407, pp 1096-1109)
COLLINS, D. C., Calculating penetration of neutron and γ radiation into underground concrete structures, 20: 1307 (RRA-M45)
COLLINS, P. D. B., Self-consistent p trajectory in new form of strip approximation, 20: 1012
COLLINS, R. D., Some experiments relating to behavior of gas-borne iodine, 20: 578 (CONF-650407, pp 830-52)
COLONIAS, John S., Magnet design applications of the magnetostatic program called TRIM, 20: 940 (UCRL-16382)
COMBS, Michael F., Comparison of possible indices of seedling vigor in corn, 20: 109
COMMONER, Barry, Conservation of the water resource: responsibility of the scientist, 20: 18
COMPERE, E. L., Prog. rpt. on SNAP-8 corrosion program, 5/65, 20: 773 (ORNL-3859)
COMPSTON, W., Rb–Sr ages of chondrules and carbonaceous chondrites, 20: 529
CONARD, Robert A., Medical findings in Marshallese people exposed to fallout: results from ten-year study, 20: 90
CONKLIN, James W., Recording lens opacities, 20: 75
CONNORS, J. F., Experimental performance of high specific impulse arc-jet engine, 20: 500
CONRAD, H., Cryogenic properties of metals, 20: 883
CONWAY, John G., Nitride and oxide bands of molybdenum, 20: 965
COOKE, Charles Franklin, Interactions of scalar field with gravitational field, 20: 1077
COPPER, D. R., Effect of uv irradiation on soluble collagen, 20: 48
COPPER, J. A., Very low-energy isomer in the decay of ^{90}Mo, 20: 1159 (UCRL-16306)
CORDERO, G., Natural leaching of uranium minerals, 20: 440

CORDES, O. L., Fission product dispersion and release from the SNAPTRAN 2/10A-3 destructive test, 20: 564 (CONF-650407, pp 512-36)

CORELLI, J. C., Recombination, trapping and annealing in electron-irradiated germanium, 20: 911

CORMACK, D. V., Variation of x-ray sensitivity of Serratia marcescens with relative humidity, 20: 99

CORNEIL, Hampton G., Method for production of radioactive substances, 20: 730

CORNISH, J. J., Diffusion and thermodynamic characteristics of nickel–chromium alloys, 20: 834 (AERE-Trans-1031)

COSTES, Didier, Cooling circuit for a liquid-moderator nuclear reactor, 20: 1403

COTTRELL, Wm. B., AEA convention on civil liability for nuclear damage, 20: 609

COTTRELL, Wm. B., Nuclear Safety, Vol. 5, No. 3, 20: 608

COTTRELL, Wm. B., Reactor site criteria, 20: 541

COUCHMAN, J. C., Use of cascade impactors for analyzing airborne particles of high specific gravity, 20: 588 (CONF-650407, pp 1162-1203)

COUDRAY, Michel, Nuclear reactor installation, 20: 1430

COURANT, R. A., Electron- and proton-transfer by Grotthuss mechanism in aqueous solution and in biological systems, 20: 340

COURTAULT, Jeannine, Ultrasonic copper and brass decontamination study, 20: 430 (CEA-R-2823)

COUSINS, L. B., Radioiodine adsorption on particulate matter, 20: 216 (CONF-650407, pp 242-75)

COVER, A., Lead-210 content of some selected foods, 20: 149 (NYO-3086-1, Pt. V)

COVER, Arthur, Analytical development, 20: 417 (NYO-3086-1, Pt.IX)

COVER, Arthur, Dietary intake of ^{226}Ra, 20: 148 (NYO-3086-1, Pt.IV)

COVER, Arthur, Distribution of ^{226}Ra and ^{228}Th in bones of beagle injected with ^{226}Ra, 20: 23 (NYO-3086-1, Pt. III)

COVER, Arthur, Radioactivity of fossil fuels, 20: 152 (NYO-3086-1, Pt. VIII)

COVER, Arthur, Radiochemical analysis of Brazilian samples from regions of high natural radioactivity, 20: 150 (NYO-3086-1, Pt.VI)

COWDER, L. R., High-temperature thermal diffusivity measurements by flash technique, 20: 823 (LA-DC-7456)

CRAIG, R. E., Radiation measurement in photobiology: choice of units 20: 15

CRAIG, Richard A., Forming uranium mononitride–uranium dioxide nuclear fuel, 20: 807

CRAM, David L., Ultraviolet-induced acantholysis in pemphigus, 20: 74

CRAWLEY, G. M., Change from strong to weak coupling between ^{25}Mg and ^{27}Al, 20: 1192

CREEK, G. E., Deposition of fission-product I on structural surfaces, 20: 574 (CONF-650407, pp 740-46)

CRISTU, M. I., Gamma radiation from interaction of neutrons with iodine nuclei, 20: 1151 (IFA-RN-20)

CROCKER, A. G., Crystallography of deformation twinning in α-uranium, 20: 850

CRONKITE, Eugene P., Kinetics of proliferation of normal and leukemic leukocytes, 20: 1 (BNL-9363)

CROOKS, J., Effect of treatment of thyrotoxicosis on exophthalmos, 20: 176

CROSBY, Robert L., Determination of part of magnesium–zirconium liquidus, 20: 812 (BM-RI-6673)

CROSSLEY, D. A. Jr., Biological elimination of radionuclides, 20: 41

CROUSE, D. J., Prog. rpt. on chemical applications of nuclear explosions, 7-9/65, 20: 469 (ORNL-TM-1275)

CROUSE, D. J. Jr., Recovery of sulfuric acid from an aqueous solution containing metal values by extraction with tertiary amines, 20: 1578

CRUZ VIDAL, Baltesar, Resonance in radiation effects, 20: 46 (PRNC-40)

CSOM, Gyula, Nuclear power plants built with fast reactors, 20: 1487

CULBERTSON, Robert J., Time constant control system for x-ray analyzers and gages, 20: 640

CULKOWSKI, Walter M., Effluent flow in non-stack releases, 20: 562 (CONF-650407, pp 455-9)

CULVER, H. N., Fission product release studies for the EGCR, 20: 581 (CONF-650407, pp 921-37)

CULVER, J. C., DCX-2 beam injection duct, 20: 1276 (ORNL-P-1511)

CULVER, J. S., Injection and accumulation—multiple-pass experiments (DCX-2), 20: 1270 (ORNL-3836, pp 15-32)

CUNNINGHAM, R. T., Electron microprobe analysis of highly radioactive samples, 20: 224 (CNLM-6352)

CURRIN, H. B., Influence of axially non-uniform heat flux on DNB, 20: 492

CUTHILL, Elizabeth, FLAME master control system, 20: 1421 (AD-611775)

CUTTS, B., Core performance for the AGR, 20: 1498

D

DABBS, J. W. T., Obtaining bursts of polarized neutrons with energies 10 to 700 kev, 20: 1134 (ORNL-P-1604)

DABROWSKI, Andrzej, Gold–silicon surface-barrier β spectrometer with multi-gard-ring, 20: 665

DADDI, L., Experimental data interpretation in threshold neutron spectrometry, 20: 1414

DAHL, Lewis K., Genetic influences on experimental hypertension in the rat, 20: 1558 (BNL-9404)

DAHL, P. F., Choice of profile parameter k_0 magnet steel for AGS magnets, 20: 930 (BNL-9553)

DAINTON, F. S., Radical and molecular yields in γ-radiolysis of water. II., 20: 392

DAINTON, F. S., Radical and molecular yields in γ-radiolysis of water. III., 20: 393

DAKOWSKI, M., Observation of fission events in mica sandwiches, 20: 652 (INR-647/I-A,VI/PH)

DAKOWSKI, Miroslaw, Lithium-drifted detectors for β and γ spectrometry, 20: 664

DALAL, Kirit, Preparation and hot pressing of UN, 20: 799

DALFES, Abdi, Nuclear reactor noise, 20: 1418

DANCEWICZ, Antoni M., Biochemical lesions induced in subcellular structures by ionizing radiation. I., 20: 108

DANELIYA, I. A., Electromagnetic wave transformation in nonequilibrium plasma, 20: 1286

DANESI, P. R., The extraction of uranium and plutonium from nitric acid solution by secondary and quaternary ammonium nitrate salts, 20: 437 (RT/CHI(65)21)

D'ANGELO, V., Experimental data interpretation in threshold neutron spectrometry, 20: 1414

DANIELSON, D. W., Release of fission products from UO_2 operating at high power rating, 20: 579 (CONF-650407, pp 885-907)

DANON, Jeanne, Radiation-induced changes in unsaturation of polyisoprene, 20: 364

DARMITZEL, R. W., Post-irradiation examination of ORNL-ETR capsules, 20: 891

DASHEN, Roger F., General features of bootstrap theory of octet enhancement, 20: 1064

DASS, Guru Vachan, Role of baryon exchanges in generating $\frac{3}{2}^+$ resonances, 20: 1014

DAVID, G., Change of suprarenal function in acute radiation injury, 20: 141

DAVID, G., Effect of nitrogen mustard poisoning on serum proteins, 20: 43

DAVIDSON, R. J., Effect of uv irradiation on soluble collagen, 20: 48

DAVIES, G. J., Growth of fiber structures from the melt, 20: 760

DAVIES, J. H., Release of fission products from UO_2 operating at high power rating, 20: 579 (CONF-650407, pp 885-907)

DAVILA, C., Conservation and stability of labeled macromolecules, 20: 2 (EUR-2419.f)

DAVIS, Harold S., Design criteria for NPR reactor building, 20: 1511

DAVIS, J. J., Gamma-emitting radionuclides in Alaskan tundra vegetation 1959, 1960, 1961, 20: 525

DAVIS, M. E., Deposition of fission-product I on structural surfaces, 20: 574 (CONF-650407, pp 730-46)

DAVIS, M. E., Identity, character, and chemical behavior of vapor forms of radioiodine, 20: 282 (CONF-650407, pp 1131-61)

DAVIS, R. C., High-current ion-beam production and injection, 20: 962 (ORNL-3836, pp 74-80)

DAVIS, R. C., Injection and accumulation—multiple-pass experiments (DCX-2), 20: 1270 (ORNL-3836, pp 15-32)

DAVIS, Robert Earl, Isotope effects in boron hydrides. X., 20: 306

DAVIS, Stephen L., Optical properties of adenylic acid and its oligomers, 20: 1575 (UCRL-16409)

DAVIS, W. Jr., Two-step process for decontaminating low-radioactivity-level process waste water, 20: 1549 (ORNL-3811)

DAVIS, William G., Heat-shield ablation and sublimation determinations through radioisotope techniques, 20: 720

DAWIHL, Walther, Temperature dependence of torsion fatigue strength in tungsten carbide–cobalt alloys, 20: 875

DE BRANGES, Louis, Hilbert spaces of analytic functions. II., 20: 736

DEENEY, F. A., Moessbauer effect in tin-rich alloys, 20: 862

DE ESTABLE, Rosita F., Cerebral and cerebellar cortex following damage from ionizing particle radiation, 20: 68

DEGNER, W., Experiences with high-energy radiation at cancer clinic, 20: 205

DEGROSSI, O., Use of ^{99m}Tc in hepatic sciatillography, 20: 197

DE HAAS, Ernst, Radioactive isotope fueled thermoelectric generators for space missions, 20: 723 (NP-15531)

DELAHAYE, R. P., Extraterrestrial radiations. I. Biological studies, 20: 122

DE LISLE, Janice M., ESR study of x-irradiated sodium thiosulfate single crystals, 20: 374

DELLER, D. J., Iron-59 absorption measurements by whole-body counting and pancreatitis, 20: 169

DELNAGE, Maurice, Production of U by Mg reduction of UF_4, 20: 761

DEMOULIN, Camille, Apparatus for heating metals to high temperatures, 20: 479

DENNIS, J. A., Slow neutron calibration of film and other γ dosimeters, 20: 648 (AERE-R-4960)
DEPORTES, Charles, Improvement of the melting-without-crucible technique, for refractory oxides, 20: 798
DEQUIN, K., Permanent automatic control of irrigation from above or below by a neutron probe regime, 20: 633
DESHPANDE, R. G., Aqueous chemistry of hafnium(IV) solvent extraction and ion exchange studies, 20: 260
DE SILVA, N. H., Toxin production by Clostridium botulinum in vacuum-packed, irradiated fresh fish, 20: 707
DE SORBO, Werres, Solute size and valence effect in superconducting alloys of transition elements, 20: 1129
DESPAIN, Alvin M., Theory of cylindrical antenna impedance as function of plasma frequency and temperature, 20: 1253 (AFCRL-65-480)
DETENBECK, Robert W., Reaction $^{14}N(p,2p)^{13}C$ at 19 Mev. Energy distributions and angular correlations, 20: 1183
DEVANATHAN, C., Transport processes in multi-component assembly on basis of generalized BGK collision model, 20: 1090
DEVARE, H. G., Level structure of ^{131}I, 20: 1201
DEVARE, S. H., Level structure of ^{131}I, 20: 1201
DEVORET, R., Indirect uv induction of prophage λ and colicin I factor, 20: 127
DEXTER, R. W., Final safety and hazards report for the SNAP-15A generator, 20: 722 (GA-4554(Rev.))
DICKEL, G., Transformation theory of separation cascades. IV., 20: 448
DIECKAMP, H. M., What happened to SNAP 10A?, 20: 1530
DIETRICH, J. R., Power reactor technology, 20: 1513
DIETZ, Russell Noss, Heterogeneous irradiation catalysis of CO_2, 20: 413
DIFFEY, H. R., Iodine cleanup in steam suppression system, 20: 576 (CONF-650407, pp 776-804)
DI GREGORIO, Humberto, Measurement of density by gamma scattering, 20: 623 (NP-15529)
DI GREGORIO, Ronald F., Techniques of magnetic-field measurement, 20: 627 (UCRL-16357)
DINCER, Turgut, Isotope survey of the karst region of southern Turkey, 20: 538
DINGUS, R. S., Energy of isomeric transition in ^{109}Ag, 20: 1174
DIVINE, Theodore Neil, Structure and evolution of model helium stars, 20: 958
DOBRESCU, S., Gamma-gamma angular correlation measurements of thermal-neutron-capture γ rays in ^{200}Hg, 20: 1152 (IFA-RN-21)
DOEDDERER, Jorge F., Measurement of density by gamma scattering, 20: 623 (NP-15529)
DOERFFEL, F. W., Experiences with high-energy radiation at cancer clinic, 20: 205
DOLEZAL, R., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
DOMANGE, Louis, Solid solutions formed by addition of sulfides of rare earths to fcc MS sulfides, 20: 332
DONNELLY, R. G., Brazing flanges to sintered, stainless steel filters for high-temperature service, 20: 786 (ORNL-TM-1252)
DONNER, W., Paramagnetic fields of nuclei, 20: 1235
DONOHUE, W. B., Effects of dose of 2,000 R of x irradiation on growth of jaws in kittens, 20: 91
DORABIALSKA, Alicja, Radiometric determination of ion self-diffusion mobilities. I., 20: 425
DORABIALSKA, Alicja, Radiometric determination of ion self-diffusion mobilities. II., 20: 327
DORST, Joseph H., Magnet design applications of the magnetostatic program called TRIM, 20: 940 (UCRL-16382)
DOSHI, G. R., Microdetermination of copper in biomaterials, 20: 254
DOTSON, Allen Clark, Interactions of the gravitational field with generalized Yang-Mills field, 20: 1115
DOUGAL, A. A., Kerr cell photography of a dynamical deuterium plasma produced in 30-kilojoule theta pinch, 20: 1255 (ARL-65-171)
DOUGAL, Arwin A., Current sheath dynamics and magnetosonic oscillations in magnetoplasmas, 20: 1262 (NASA-CR-309)
DOWD, Richard Michael, Study of $K^+ \to \pi^+ + \pi^0 + \pi^0$ decays, 20: 1028
DOYLE, Carroll F., Irradiation polymerization of compressed particulate trioxane, 20: 415
DREICER, H., Line shape measurements on electron cyclotron harmonics emitted by laboratory plasma, 20: 1258 (LA-DC-7364)
DREW, Robert, Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1, Pt. I)
DREW, Robert T., Natural radiation dose to indigenous rodents on the Morro do Ferro, Brazil, 20: 151 (NYO-3086-1, Pt. VII)
DROST, H., Anode region of delayed glow discharge in oxygen, 20: 1088
DROST, H., Behavior of electrons in stratified low-pressure discharge, 20: 1086
DUBRAU, H.-J., Development of nuclear power, 20: 1494
DUCHESNE, J., Influence of molecular weight on radiolytic yield of DNA in solid phase, 20: 420
DUCLOS, J., A search for the decay of $\pi^0 \to 3\gamma$, 20: 1007
DUFNER, Andrew Joseph, Analysis of electron polarization and scattering asymmetries, 20: 1249
DUGAN, Virgil L., Highly stable temperature control unit for medium-volume temperature chambers, 20: 625 (SC-TM-65-268)
DU MOND, Jesse W. M., Fundamental constants of physics and chemistry in 1965, 20: 922
DUNCAN, Thomas R., Organic liquid moderated and cooled nuclear reactors, 20: 1429
DUNGAN, Robert H., Mechanical properties of some $PbZrO_3$–$PbTiO_3$ ferroelectrics, 20: 828 (SC-DC-65-1588)
DUNLAP, J. L., Injection and accumulation—single-pass experiments (DCX-1), 20: 1269 (ORNL-3836, pp 1-14)
DUPUY, Gerard, Drive mechanism for reactor control rods, 20: 1388
DUPUY, Gerard, Support structure for vertical stack of solid moderator, 20: 1404
DURSO, John William, Higher angular momentum nucleon-nucleon phase shifts, 20: 1029
DUTHIE, Richard E. C., Supplemental insert sheets for engineering materials list, 20: 464 (TID-4100(Suppl.29))
DWIGHT, D. J., Leak-testing sealed sources of ^{226}Ra and ^{228}Th, 20: 601 (RCC-R-176(Add.))
DWORSCHAK, F., Stage III annealing in proton-irradiated noble metals, 20: 902
DYER, Frank F., Trace elements in human hair, 20: 268
DZYKOVICH, I. Ya., Distribution of elements during formation of sintered alloys in W–Ni–Fe system, 20: 865

E

EASSON, E. C., Management of polycythemia vera, 20: 189
EASTON, Dewey Sloan, Method of increasing critical current density of hard superconducting alloys and the products thereof, 20: 1121 (Al-Trans-97)
EBERT, P. J., Energy dependence of free radical production in alanine, 20: 394
ECK, G., Dose burden in x-ray diagnosis, 20: 182
ECK, J. S., Efficient Moessbauer scattering technique, 20: 1250
ECK, J. S., Moessbauer scattering in ^{169}Tm, 20: 1251
EDELSTEIN, Richard M., Muon capture in ^3He, 20: 1209
EDGE, Charles Kay, Moessbauer effect at high pressure, 20: 1344
EDVARSON, K., Relationship between ^{131}I deposited on pasture and its concentration in milk, 20: 598 (NP-15568)
EDWARDS, A. G., DFR as an irradiation facility, 20: 1503
EDWARDS, D. O., Heat capacity and other properties of hexagonal close-packed ^4He, 20: 1336
EDWARDS, J. A., Superheat with boiling alkali metals, 20: 482 (ORNL-P-1659)
EDWARDS, John O., Prog. rpt. on oxyanions and peroxides, annual, 8/64–8/65, 20: 1571(R) (TID-22186)
EDWARDS, R. S., Injection and accumulation—single-pass experiments (DCX-1), 20: 1269 (ORNL-3836, pp 1-14)
EGGLETON, A. E. J., Radioiodine adsorption on particulate matter, 20: 216 (CONF-650407, pp 242-75)
EHN, E., Determination of corrosion products in the fuel solution of the BER reactor, 20: 1541
EHRHARDT, H., Inelastic scattering of low-energy electrons on methane, propane, and n-heptane, 20: 335
EICHELBERGER, T. W., Irradiation embrittlement of pressure vessel steels. II., 20: 833 (WERL-8844-5)
EISENBUD, Merril, Natural radiation dose to indigenous rodents on the Morro do Ferro, Brazil, 20: 151 (NYO-3086-1, Pt.VII)
EISENBUD, Merril, Prog. rpt. on radioactivity studies, annual, 12/64–11/65, 20: 146 (NYO-3086-1)
EISENBUD, Merril, Radioactivity of fossil fuels, 20: 152 (NYO-3086-1, Pt.VIII)
EISENBUD, Merril, Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1, Pt.I)
EISENHAUER, C., Image source technique for calculating reflection of γ rays or neutrons, 20: 1061
EJIRI, Hiroyasu, Measurement of conversion electrons from (p,2n) reactions on vibrational nuclei, 20: 1173
EKBERG, K., Survey of values of the 2200 m/s constants for four fissile nuclides, 20: 1164
EKMAN, L., Relationship between ^{131}I deposited on pasture and its concentration in milk, 20: 598 (NP-15568)
EKSTEIN, H., Rigorous symmetries of elementary particles, 20: 1060
EL-ABD, Abd El-Hamid Ali, Hypothetical bases of the general theory of relativity and stability of relativistic orbits, 20: 1116
EL-BEHAY, A. Z., Reaction (d,p) of ^{23}Na in energy range from 1.0 to 2.5 Mev, 20: 1185
ELBEK, Bent, What can we learn about heavy nuclei from nuclear reactions? 20: 1229

ELEY, D. D., Irradiation of alumina catalysts, 20: 368
ELLIOTT, Donald E., Tri-n-octylphosphine sulfide: a selective organic extractant, 20: 244
ELLIOTT, Edward Roe, Nuclear reactor fuel element, 20: 1445
ELLIOTT, Edward Roe, Tubular container for nuclear fuel, 20: 1449
ELLIOTT, R. O., Effects of dilute rare-earth additions on electrical conductivity of cerium at low temperatures, 20: 864
ELLIS, W. G., Effect of nitric acid etching on nitrogen and carbon analysis of uranium metal, 20: 230 (NLCO-965, pp 4.1-5)
ELLYIN, F., Collapse of cylinder/sphere intersecting pressure vessels, 20: 465
ELVING, Philip J., Application of polarography to biological problems, 20: 44 (COO-1148-98)
EMBURY, J. D., Microstructural aspects of stress-corrosion failure, 20: 779
EMELEUS, K. G., Notes on plasma oscillations, 20: 1254 (ARL-65-151)
EMERSON, J. A., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
EMLEY, Eward Frederick, Production of material based on magnesium for reactor parts, 20: 801
ENDEBROCK, Roy W., Uranium mononitride fuel and method of making, 20: 803
ENDOW, N., Prog. rpt. on sorption of gases on metal surfaces in ultrahigh vacuum, 5/15–8/15/65, 20: 916 (SRIA-425-6)
ENDT, P. M., Spin and parity determinations in s-d shell nuclei, 20: 1230
ENGEL, Eric, X rays and Philadelphia chromosome, 20: 94
ENGEL, L. B. Jr., Prog. rpt. on evaluation of high-strength Nb alloys for alkali metal containment, 7/25/62–7/10/64, 20: 768 (NASA-CR-54226)
ENGELMANN, C., Possibilities offered by γ spectrometry in nondestructive measurements on fuel elements, 20: 236 (AEC-tr-6621)
ENNEREST, K., Preparation of plate fuel elements for research reactors, 20: 1535
ENRIQUES, L., Interaction of ion beam with a plasma, 20: 1259 (MATT-366)
EPSTEIN, William W., Several dicarboxylic acids in water and D_2O, 20: 350
ERDMAN, Howard E., Fast-neutron effects on productivity of young and old flour beetles, Tribolium castaneum, 20: 84
ERGEN, W. K., SPERT-I destructive test with UO_2 fuel, 20: 1416
ERGINSOY, C., Axial and planar effects in energy loss of protons in silicon single crystals, 20: 1334
ERHARDT, P., Dependence of light scattering by polymer films on polarization angle, and its relationship to randomness of orientation fluctuations, 20: 1572 (TID-22196)
ERIKSSON, A., Relationship between ^{131}I deposited on pasture and its concentration in milk, 20: 598 (NP-15568)
ERINGEN, A. C., Stress distribution at two normally intersecting cylindrical shells, 20: 466
ERKES, P., Particular aspects of Ardenne nuclear power plant, 20: 1480
ESCHNAUER, H., Preparation of plate fuel elements for research reactors, 20: 1535
ESSMANN, U., Significance of electron microscopic contrast appearance of defect agglomerates in neutron-irradiated copper. 20: 906
ESTABLE-PUIG, Juan F., Cerebral and cerebellar cortex following damage from ionizing particle radiation, 20: 68
EUBANK, Lowell D., Coated metallic uranium article and method of making, 20: 802
EVANS, B., Prog. rpt. on sorption of gases on metal surfaces in ultrahigh vacuum, 5/15–8/15/65, 20: 916 (SRIA-425-6)
EVANS, J. C., Infrared band width of the nitrate ion ν_2 mode, 20: 324
EVANS, J. S., Decay of ^{101m}Rh and ^{101g}Rh, 20: 1205
EVERHART, Edgar, Measurements of resonant electron capture in close H^+-on-H collisions, 20: 971
EWING, C. T., High-temperature properties of potassium, 20: 286 (NRL-6233)
EWING, R. A., Fission-product deposition in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
EYRAUD, Charles, Determination of characteristics of porous barriers and instrument for practical application of said method, 20: 728
EYRAUD, Yves, Determination of characteristics of porous barriers and instrument for practical application of said method, 20: 728
EYRING, Edward M., Several dicarboxylic acids in water and D_2O, 20: 350

F

FABER, P., Prophylactic analysis of fuel element damage in boiling water reactors, 20: 853
FAINBERG, V. Yu., Certain features specific to quantum theory of elementary particles, 20: 1035
FAITH, T., Prog. rpt. on electron cyclotron resonance plasma accelerator, 1–12/64, 20: 497 (AD-612175)
FAM KUGH TU, Structure of vertex parts in symmetries SL(6) and U(12), 20: 1055 (JINR-P-2338)
FARADI, L., Change of suprarenal function in acute radiation injury, 20: 141
FAROUK, M. A., Reaction (d,p) of ^{23}Na in energy range from 1.0 to 2.5 Mev, 20: 1185
FAWCETT, Sydney, Control systems for nuclear reactors, 20: 1407
FEDERIGHI, T., Recovery of Al–Si alloys neutron irradiated at 78°K, 20: 905
FEDOROV, G. B., Diffusion and thermodynamic characteristics of nickel–chromium alloys, 20: 834 (AERE-Trans-1031)
FEDOROV, V. V., Planning of n-p scattering experiments for determining the most probable set of phase shifts, 20: 994 (JINR-P-2332)
FEIGE, Y., Relative toxicity of radionuclides, 20: 145 (IA-989)
FEITH, A. D., Measurements of thermal conductivity and electrical resistivity of molybdenum, 20: 821 (GE-TM-65-10-1)
FEITH, Allen D., Thermal conductivity of several ceramic materials to 2500°C, 20: 820 (GE-TM-64-10-4)
FELDER, R. M., Collision density of hot atoms, 20: 966
FENSTER, Stanley, Spin and parity determination of decaying fermion states, 20: 1078
FENYES, T., Investigation of the α spectrum of ^{149}Gd, 20: 1220
FERBEL, T., Antiproton-proton interactions in flight, 20: 1052
FERGASON, L. A., Method for trace analysis with electron microprobe, 20: 225 (CONF-650810-2)
FERRARI, S., Uranium and fission products release from uranium dioxide, 20: 894 (RT/CHI(65)27)
FERRARO, J. R., Infrared spectra of anhydrous rare-earth nitrates from 4000-100 cm^{-1}, 20: 308
FESENKO, V. V., Evaporation of lanthanum hexaboride, 20: 329
FIAM, B., Effect of nitrogen mustard poisoning on serum proteins, 20: 43
FIELD, J. H., Experimental studies of transient effects in fast reactor fuels. II., 20: 892 (GEAP-4804)
FIGUEROA, William G., Short-term retention of ^{85}Sr and estimation of initial ^{90}Sr burdens in humans, 20: 32
FILIPOV, Alexander M., Simulated radiation detector, 20: 689
FILIPPOV, N. V., Generating high-voltage pulses with use of plasma pinch effect, 20: 1281 (AD-620824)
FIL'KOV, L. V., Role of one-dimensional integrals in Mandelstam representation for γ-quantum Compton scattering of protons, 20: 1026
FILLOLEAU, Etienne, Nuclear reactor control rod operating device, 20: 1369
FINCH, Lester M., Fast fuel test reactor, 20: 1546
FINKE, Peter, Production of etch figures on oriented surfaces of high-melting metals, 20: 866
FINKEL, E. E., Characteristics of radiation crosslinkage of polyolefins and their copolymers in N_2O medium, 20: 402
FIRESTONE, R. F., Effects of temperature in radiolysis of methane and propane, 20: 381
FISCHER, Erhard, Boiling water nuclear reactor producing superheated steam, 20: 1522
FISCHER, G., Microwave observation of proximity effects in magnetic fields, 20: 1124
FISCHER, H., Comparison of effect of mitomen and x rays on ascites cells of Ehrlich carcinoma in mice, 20: 118
FISCHER, H., Roentgen-induced radiation injury of retina in newborn mice, 20: 117
FISCHER, J. E., Recombination, trapping and annealing in electron-irradiated germanium, 20: 911
FISCHER, R. B., Hot extrusion of fine plutonium wire, 20: 787 (RFP-623)
FISHER, D. A., Comparison of thyroidal iodide accumulation and thyroxine secretion in euthyroid subjects, 20: 36
FISHER, J. R., Prog. rpt. on Elk River Reactor operations, semiannual, 7–12/64, 20: 1453 (ACNP-65532)
FLAHAUT, Jean, Solid solutions formed by addition of sulfides of rare earths to fcc MS sulfides, 20: 332
FLEROV, G. N., Synthesis of fissionable isomer in $^{241}Am(n,\gamma)^{242g}Am$ reaction, 20: 1155 (JINR-P-2347)
FLETCHER, John F., Method of controlling nuclear reactor, 20: 1408
FLINN, P. A., Moessbauer effect in ^{119}Sn, 20: 1335
FLOWERS, R. H., Equilibrium metal vapor pressures over alkaline-earth carbides, 20: 810 (AERE-R-5011)
FLOWERS, R. H., Vaporization of europium dicarbide, 20: 811 (AERE-R-5012)
FOELL, W. K., CEP. Monte Carlo program for the calculation of first-flight escape probabilities for finite cylinders, 20: 1133 (IDO-17075)
FOERSTE, J., Stationary magnetohydrodynamic flow problem, 20: 1093
FOLGMANN, August, Current generating plant operating with gas-cooled reactor, 20: 1518
FOMICHENKO, K. V., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
FONG, R., Time delay for wave packets in nonrelativistic scattering theory with inelastic channels present, 20: 1067
FOREST, A. E., Magnetic analysis of the $^{51}V(d,p)^{52}V$ reaction, 20: 1167
FORSTNER, James L., Nuclear safety control in chemical processing facilities of Savannah River Plant, 20: 431 (CONF-651103-7)

FORTESCUE, Peter, Fuel elements for nuclear reactors, 20: 1451
FORTESCUE, Peter, Gas-cooled reactor with improved coolant flow path arrangement and fuel assembly therefor, 20: 1435
FOSTER, J. D., Fringe counting laser interferometers for industrial length measurement, 20: 626 (SCL-DC-65-92)
FOSTER, Margaret Carter, Production of η and its charged decay modes, 20: 1027
FOURE, Claude Desire, Process and devices of heat exchange and nuclear reactor embodying same, 20: 1400
FOWLER, K. A., Determination of part of magnesium–zirconium liquidus, 20: 812 (BM-RI-6673)
FOX, Kenneth, Reduced matrix element of an irreducible spherical tensor operator, 20: 1329
FRAEKI, R., Measured and predicted variations in fast neutron spectrum when penetrating laminated Fe–D_2O, 20: 1304 (AE-196)
FRAEKI, R., Variations in fast neutron spectrum in massive shields of water and concrete, 20: 1318
FRAHN, W. E., Analysis of ^{3}He-nucleus scattering and polarization, 20: 1171
FRANC, Z., Measurement of soft β-radiation in biological material with aid of liquid scintillators. II., 20: 253
FRANCINI, M., Oscillographic polarography of oxygen ions in molten nitrates, 20: 285 (EUR-2496.e)
FRANCOVA, V., Measurement of soft β-radiation in biological material with aid of liquid scintillators. II., 20: 253
FRANK, Bruce Hill, Deuterium exchange studies of a model amide compound, 20: 354
FRANK, R. G., Prog. rpt. on evaluation of high-strength Nb alloys for alkali metal containment, 7/25/62–7/10/64, 20: 768 (NASA-CR-54226)
FRANKEL, R. B., Cerium magnesium nitrate temperature scale from nuclear orientation, 20: 1338
FRANKLIN, J. C., Applications of spark source mass spectrography to analysis of alloys and pure elements, 20: 235 (Y-KG-28)
FRANKLIN, J. C., Irradiation embrittlement of low-boron type 304 stainless steel, 20: 898
FRANTSEVICH, I. N., Distribution of elements during formation of sintered alloys in W–Ni–Fe system, 20: 865
FRANZEN, J., Evaluation of marrow cell distribution for reduction of bone marrow dose in x-ray study series, 20: 180
FRAUTSCHI, Steven C., General features of bootstrap theory of octet enhancement, 20: 1064
FRAZEE, Russell T., Reversed-phase chromatographic separation of zirconium and hafnium, 20: 240
FRECK, David Vernon, Radiation detector and discriminator utilizing semiconductor solid-state detector, 20: 691
FREDRIKSSON, L., Relationship between ^{131}I deposited on pasture and its concentration in milk, 20: 598 (NP-15568)
FREEDMAN, M. S., Low-intensity first-forbidden β-decay branch in ^{45}Ca, 20: 1206
FRENCH, J. B., Multipole sum rules for single-nucleon-transfer spectroscopy, 20: 1190
FRENCH, R. L., Calculating penetration of neutron and γ radiation into underground concrete structures, 20: 1307 (RRA-M45)
FRENCH, R. L., Neutron and γ radiation penetration into concrete-shielded underground structures, 20: 1310 (RRA-T51)
FRENCH, R. L., Penetration of neutron and γ radiation through the openings of underground structures, 20: 1308 (RRA-T41)
FREYTAG, D., A search for the decay of $\pi^0 \rightarrow 3\gamma$, 20: 1007
FRIAR, E. M. Jr., Plasma diagnostics by second derivative methods, 20: 1296
FRIDMAN, Sh. D., Determination of water supplies in snow deposits by aerial γ exposure, 20: 549
FRIEDBERG, Felix, Gamma irradiation effects on solid ribonuclease, 20: 53
FRIEDMAN, Herbert, Cosmic x rays and γ rays, 20: 985
FRIEDRICH, Otto M. Jr., Current sheath dynamics and magnetosonic oscillations in magnetoplasmas, 20: 1262 (NASA-CR-309)
FRIEMAN, E., Maximal ordering stability problem, 20: 1260 (MATT-370)
FRISCH, O. R., Feasibility of coal-driven power stations, 20: 610
FRITSCHE, Bernd, Effect of ionizing radiation on system sulfur dioxide–oxygen. IV., 20: 412
FRITZ, George J., Mass spectrometric measurement of ^{18}O in small carbon dioxide samples, 20: 243
FRITZ, James S., Reversed-phase chromatographic separation of zirconium and hafnium, 20: 240
FROMM, Eckehard, The composition of gases evolved during electron beam melting of vanadium, niobium, and tantalum, 20: 872
FRONSDAL, C., Non-compact groups. II., 20: 739
FRONTEROTTA, G., Optika 2—a program for magnetic channel design, 20: 934,(ISS-65/4)
FUJII, Kyoichi, Acute radiation death of mice with massive total-body γ irradiation, 20: 105
FUJIMURA, T., Detection of embrittlement in steels by means of hardness measurements, 20: 860
FUJITA, Akira, Studies on fallout particles. IV., 20: 535
FULLER, D. D., Prog. rpt. on application of gas-lubricated bearings to high speed turbomachinery, final, 6/65, 20: 458 (NYO-2512-15)
FULTYN, R. V., Airborne radioactivity and contamination patterns from transient test of nuclear rocket engine, 20: 565 (CONF-650407, pp 537-56)
FULTZ, S. C., Photoneutron cross sections of ^{6}Li, 20: 1217
FUNKE, L., Coincidence measurements in decay of ^{187}W, 20: 1179
FUNKE, L., Decay of ^{181}Hf, 20: 1177
FUNKE, L., Decay ^{153}Sm(β^-)^{153}Eu, 20: 1178

G

GABRIEL, E., Commissioning [of Dungeness A and B], 20: 1505
GAERTNER, W. W., Direct observation of nonlinear scattering of electrons by laser beam, 20: 1003
GAGNON, William L., Nanosecond ferrite-core magnet system for beam switching, 20: 939 (UCRL-16364)
GAGNONI SCHIPPISI, G., Proctosigmoiditis from irradiation, 20: 192
GAIRON, P., Relative toxicity of radionuclides, 20: 145 (IA-989)
GALANIN, A. D., Possible connection between weak and strong interactions, 20: 1076
GALANTINE, R. M., Magnetic moments and vehicle torques in the SNAP 10A, 20: 1528 (NAA-SR-11207)
GAMBARDELLA, G., Reactor for organic moderated critical experiments, 20: 1413 (RT/ING(65)4)
GAMBINO, Jerome J., Mechanisms of radiation resistance in pocket mice, 20: 114
GANCZ, M., Microheterometric method for determination of vanadium, 20: 257
GANGULY, A. K., Containment and siting of high power reactors, 20: 1460 (CONF-650407, pp 1015-34)
GARBER, Lawrence O., Radiation in pregnancy, 20: 195
GARCIA, A., Magnetic analysis of the ^{51}V(d,p)^{52}V reaction, 20: 1167
GARCIA, R., Ultrasonic-induced cavitation studies in lead–bismuth alloy at elevated temperatures, 20: 771 (NP-15558)
GARDNER, H. R., Compositional and pressure effects in the plutonium–gallium system, 20: 815 (BNWL-SA-209)
GARDNER, H. R., Fatigue behavior of plutonium-1.0 wt.% gallium δ-stabilized plutonium, 20: 816 (BNWL-SA-210)
GARRETT, D. A., Neutron radiography utilizing gadolinium activation foils, 20: 621 (LA-DC-6978)
GARVEY, G. T., Change from strong to weak coupling between ^{25}Mg and ^{27}Al, 20: 1192
GASC, C., Plastic deformation and consolidation of polycrystalline beryllium from room temperature to 500°C, 20: 856
GASKIN, E. Reed, Increased granuloma formation from absorbable sutures, 20: 712
GAT, Uri, Design concepts for core structure of molten salt experimental reactor, 20: 1423
GATES, John E., Radiation stability of uranium mononitride, 20: 888 (BMI-1731)
GATOS, H. C., Impurity distribution in single crystals. I., 20: 1573 (TID-22314)
GATTYS, Franz-Josef, Depository for containers of radioactivity possessing substances, 20: 615
GAUTHRON, Maurice, Method of maintaining sheathing contact in hollow fuel elements during nuclear reactor operation, 20: 1450
GAVOSTO, F., Behavior of DNA synthesis in different phases of S-period in chromosomes of human acute leukemia, 20: 20 (EUR-2451.e)
GAYRAL, Marcel, Determination of characteristics of porous barriers and instrument for practical application of said method, 20: 728
GELBARD, E. M., Invariant imbedding and integration techniques of reactor theory, 20: 1415
GENS, T. A., Yield of UN during carbothermic reduction of UO_2 in presence of pure N or N mixed with H_2 or inert gas, 20: 288 (ORNL-TM-1264)
GEORGE, D., Equipment for maintenance of high-purity atmospheres in glove boxes, 20: 475 (AERE-M-1491)
GEORGE, J., Indirect uv induction of prophage λ and colicin I factor, 20: 127
GEORGE, J. H. B., Isotopes in industry. Trends in industrial use of radioisotopes and ionizing radiation, 20: 702 (NYO-3337-16)
GERARD, Victor Jean, Shock-absorbing device for nuclear reactor control rods, 20: 1393
GERSHTEIN, S., Muon K production in heavy hypernuclei, 20: 1225
GERSTEIN, B. C., Magnetic transitions in several rare earth metals, 20: 851
GERTH, Nancy, Localized γ irradiation from ^{60}Co on synthesis of collagen by subcutaneous granulomas, 20: 52
GEYMER, D. O., Mechanism of radical decay in irradiated polyethylene, 20: 385
GIAQUINTO, L., Uranium and fission products release from uranium dioxide,

20: 894 (RT/CHK(65)27)
GIBBONS, F. L., Interactions of 14.6-Mev neutrons in iron, ^{7}Li, and carbon, 20: 1144 (AD-614451)
GIBBS, W. J., Meteorological implications of measurements of ^{90}Sr in Australia, 20: 523
GIBSON, W. M., Axial and planar effects in energy loss of protons in silicon single crystals, 20: 1334
GIESEKE, J. A., Critical analysis of the blowdown accident, 20: 570 (CONF-650407, pp 609-40)
GIETZELT, F., Experiences with high-energy radiation at cancer clinic, 20: 205
GIFT, E. H., Comparison of ^{238}U resonance calculation by modified GAM-I, GAM-II, and the Hellstrand formulae, 20: 1158 (ORNL-TM-1296)
GILLES, Paul W., Thermodynamics of vaporization of nuclear materials at high temperatures, 20: 283 (COO-1140-129)
GILLES, Pierre, Determination of characteristics of porous barriers and instrument for practical application of said method, 20: 728
GILLIERON, Claude, Machines for loading and unloading channels of nuclear reactor, 20: 1402
GILMAN, R., Effect of radiation on activity of reticuloendothelial cells in organ cultures of lymph node and thymus, 20: 85
GILMORE, R. R., Equilibrium temperature for the plutonium α-β transformation, 20: 822 (LA-DC-7278)
GINDLESPERGER, J. L., Use of cut-crown magnesium in production of uranium metal, 20: 749 (NLCO-965, pp 1.1-5)
GIORDANO, S., Dispersion relation and frequency characteristics of alternating periodic structure for linear accelerators, 20: 931 (BNL-9554)
GIRDLER, R. M., Handling of low- and medium-level liquid waste at Savannah River Plant, 20: 1548 (DPSPU-65-30-30)
GIUDICI, G., Determination of air stability according to Pasquill's criteria for Italian stations, 20: 515 (RT/PROT(65)17)
GLASCOCK, H. H. Jr., Diffusion-sorption pumping, 20: 507
GLAUBER, R. J., Correlation functions for coherent fields, 20: 1063
GLAUDEMANS, P. W. M., Shell model calculations in $29 \leq A \leq 40$, 20: 1231
GLUBRECHT, H., Activation analysis and textile research, 20: 238 (NP-tr-1293)
GNAEDINGER, R. H., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
GNIEWEK, J. J., Cryogenic aspects of Project Sherwood magnets and magnet materials, 20: 1264 (NBS-8843)
GOEBEL, K., Enrichment of tritium by diffusion through palladium, 20: 272
GOERGENYI, Tibor, Metallographic preparation of nuclear fuel particles, 20: 797
GOETTE, H., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
GOLD, Albert, Excited states of solid Ar:H. II., 20: 1337
GOLD, Richard R., Analysis of propagation of plasma waves in spoke-wheel magnetic field, 20: 1288
GOL'DANSKII, V. I., Study of polymer mixture by radiothermoluminescence, 20: 366
GOLDHABER, G., K^* production in $K^+ + n$ and $K^+ + p$ reactions, 20: 1010
GOLDHABER, Gerson, Diffraction scattering of virtual pions and the A_1 enhancement, 20: 1008
GOLDHABER, Gerson, K^+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
GOLDHABER, S., K^* production in $K^+ + n$ and $K^+ + p$ reactions, 20: 1010
GOLDHABER, Sulamith, Diffraction scattering of virtual pions and the A_1 enhancement, 20: 1008
GOLDHABER, Sulamith, K^+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
GOLDING, R. M., ESR study of x-irradiated sodium thiosulfate single crystals, 20: 374
GOLDREICH, P., Gravitational stability of uniformly rotating disks, 20: 952
GOLDREICH, P., Spiral arms as sheared gravitational instabilities, 20: 953
GOLDRING, H., Infrared spectra and intensity enhancements in solutions of hydrogen halides in liquid xenon, 20: 311
GOLUB, G. V., Generating high-voltage pulses with use of plasma pinch effect, 20: 1281 (AD-620824)
GOLUB, Morton A., Comparison of uv and γ-induced production of unsaturation and color in polyvinyl chloride, 20: 384
GOLUB, Morton A., Radiation-induced changes in unsaturation of polyisoprene, 20: 364
GOOD, George Lawrence, Leaching and redistribution of metabolites in cuttings propagated under intermittent mist, 20: 21 (NYO-2598-25)
GORBUNOV, L. M., Electromagnetic wave scattering in plasma, 20: 1285
GORDIENKO, S. P., Evaporation of lanthanum hexaboride, 20: 329
GORDON, G., Oxygen-18 exchange reactions between gaseous oxygen and certain oxygen-containing inorganic salts, 20: 422
GORELCHIK, K. I., Behavior in lungs of ($^{144}CeF_3$) with intratracheal introduction, 20: 38
GORIN, E., Prog. rpt. on evaluation of β irradiation of pressurized reactions, 11/63–10/64, 20: 355 (NYO-2978-42)
GORLE, F., Powder-agglomeration method for fabrication of spherical fuel particles, 20: 793
GOSS, David Lane-Norton, Reactions (d,p) on ^{28}Si and ^{27}Al, 20: 1244
GOSSELIN, Charles M., Residual-gas analysis of oil-diffusion-pumped uhv system, 20: 506
GOSSET, J., Possibilities offered by γ spectrometry in nondestructive measurements on fuel elements, 20: 236 (AEC-tr-6621)
GOTTA, H., Use of ^{99m}Tc in hepatic scintillography, 20: 197
GOTTBRATH, Judith Ann, Isotope effects in boron hydrides. X., 20: 306
GOULD, Thelma Clark, Comparative study of interstitial cell tumors of rat testis induced by cadmium injection and by vascular ligation, 20: 10 (TID-21261)
GRABER, H., Coincidence measurements in decay of ^{187}W, 20: 1179
GRABER, H., Decay of ^{181}Hf, 20: 1177
GRABER, H., Decay $^{153}Sm(\beta^-)^{153}Eu$, 20: 1178
GRABOVSKII, Yu., Matrix elements for inelastic scattering of heavy particles. II., 20: 1054 (JINR-P-2328)
GRAF, Leonard R., Development and calibration of the PR-3 flowmeter, 20: 620 (COO-401-118)
GRAHAM, John B., Damage to small intestine by radiotherapy, 20: 210
GRAU, P., Particular aspects of Ardenne nuclear power plant, 20: 1480
GRAUMAN, J., Analysis of 3587 τ^+ decays, 20: 1011
GRAY, J. L., Future of nuclear power in Canada, 20: 1454 (AECL-2293)
GREEN, J. H., Radiochemical analyses for ^{90}Sr, ^{137}Cs, ^{226}Ra, and ^{40}K in materials, 20: 156
GREENHALGH, G. H., Big future for the AGR, 20: 1502
GREENHOW, Charles R., Development of γ radioisotope thrustor, 20: 724
GREENOUGH, G. B., AGR fuel, 20: 1499
GREESON, R. L., Technique for plutonium-electrolytic swab etching, 20: 751 (RFP-543)
GREIG, W. R., Effect of treatment of thyrotoxicosis on exophthalmos, 20: 176
GREITZ, U., Relationship between ^{131}I deposited on pasture and its concentration in milk, 20: 598 (NP-15568)
GRENIER, C. G., Magnetocaloric effects and enthalpy in mixed state of superconducting niobium, 20: 1122
GRIBBLE, R. F., Kerr cell photography of a dynamical deuterium plasma produced in 30-kilojoule theta pinch, 20: 1255 (ARL-65-171)
GRIFFEN, Allen B., Prog. rpt. on occurrence of chromosomal aberrations in pre-spermatocytic cells of irradiated male mice, final, 1/58–5/65, 20: 65 (TID-22174)
GRIFFIN, E. B., Applications of spark source spectrography to analysis of alloys and pure elements, 20: 235 (Y-KG-28)
GRIFFING, George W., Use of Langevin equation of Brownian motion for analyses of cold and slow neutron scattering by liquid methane, 20: 313
GRIFFITH, Peter, Prog. rpt. on two-phase momentum flux and design of a heat pipe, 6/65, 20: 483 (TID-22224)
GRIFFITHS, D. J., Velocity fields of helium II carrying a heat current, 20: 1130
GRINDSTAFF, Teddy Hodge, Adsorption of n-undecanoic and n-nonadecanoic acids on copper and nickel single crystals, 20: 1570 (TID-22150)
GRISHANOVA, S. I., M1 excitation of ^{9}Be nucleus, 20: 1222
GRISHIN, V. L., Spot welding of niobium, 20: 789 (AD-619333)
GRISHINA, A. D., Spot welding of niobium, 20: 789 (AD-619333)
GRIST, Kon L., Inactivation of enzymes by uv light. V., 20: 51
GROSS, E. E., Polarization studies at the Oak Ridge isochronous cyclotron, 20: 1157 (ORNL-P-1616)
GROSSETETE, B., Scattering of 150- and 300-Mev positrons and electrons from bismuth, 20: 913 (LAL-1142)
GROSSMANN, William Jr., Theory and experiment of coaxial plasma accelerator, 20: 1299
GRUHLE, W., Difference spectrum of α particles after β decay of $^{8}Li \rightarrow {}^{8}Be$, 20: 1176
GUBLER, W., Statistical variations of infrared radiation of Ar discharge. I., 20: 1293
GUDKOV, V. S., Isotopic exchange of cyclobutane with deuterium on evaporated metal films, 20: 304
GUERRE, J., Post-radiotherapy rectitis, 20: 178
GUERY, Marcel, Preparation of pulse-producing miniature ionization chamber for use as neutron detector, 20: 680
GUILLORY, John U., Interchange stabilization by incomplete line-tying, 20: 1280 (UCRL-16055)
GUNDERSEN, Roy M., Hydromagnetic simple wave flow in nonuniform ducts. II., 20: 1091
GUNN, Samuel A., Comparative study of interstitial cell tumors of rat testis induced by cadmium injection and by vascular ligation, 20: 10 (TID-21261)
GUPTA, S. S., Chromatographic separation of rare earths and uranium from thorium, 20: 449
GUREVICH, A. V., Radiational acceleration of plasma, 20: 1291
GUREVICH, G. L., Some questions of the theory of two-photon processes,

20: 1000
GURVICH, L. V., Study of energies of the metal-hydroxyl bonds in molecules CaOH, SrOH, and BaOH, 20: 294 (UCRL-Trans-1239(L))
GUSEV, S. I., Determination of cerium in magnesium alloys by means of a vanadium(II) salt, 20: 274
GUSTAFSON, P. F., Radioactive layer over Barrow, Alaska, attributed to Chinese nuclear test of October 16, 1964, 20: 531
GWYNNE, Peter, Time reversal, 20: 918
GYIMESI, Zoltan, Safety problems of reactors, 20: 1353

H

HAAHR, V., Neutronic method for measuring water content in soil, 20: 632
HACKNEY, Stanley, Improvements in or relating to nuclear reactors, 20: 1424
HACKNEY, Stanley, Nuclear reactor with coolant non-return valves in pressure vessel, 20: 1433
HAFFEMAYER, Marcel, Nuclear reactor control rod operating device, 20: 1369
HAGEN, C. R., Noncovariance of the Dirac monopole, 20: 1069
HAIMSON, Jacob, Linear accelerator, 20: 947
HAJDUKOVIC, S. I., Survival and recovery of fertility of male rats irradiated with a dose of 600 R, 20: 136
HAKURA, Yukio, Geomagnetic coordinates corrected by higher order spherical harmonic terms, 20: 1104
HALL, R. R., High-current ion-beam production and injection, 20: 962 (ORNL-3836, pp 74-80)
HALNAN, K. E., Management of polycythemia vera, 20: 189
HALPERN, Gerald, Beam-plasma interaction and radiating plasma waves, 20: 1267 (NYO-2813-34)
HALSALL, M. J., Temperature-dependent resonance integrals in UO_2 and ThO_2, 20: 1148 (CRRP-1222)
HALZL, Jossef, Heavy water and organic reactors, 20: 1485
HALZL, Jossef, Special use of nuclear power, 20: 1422
HAMA, Masaharu, Use of hematopoietic tissues for treatment of mice lethally irradiated with γ rays. I., 20: 133
HAMER, W. J., Testing of ten-ton UF_6 cylinders, 20: 593 (KY-500)
HAMILL, W. H., Paramagnetic resonance of alkyl radicals from dissociative electron attachment in γ-irradiated organic glass, 20: 371
HAMM, R. N., Studies of collective electron oscillations in metals by optical methods, 20: 1326 (ORNL-P-1600)
HAMMEL, E. F., Narrow channel flow, 20: 1119 (LA-DC-7357)
HAMMEL, R. L., Low-energy radiation damage to surfaces, 20: 910
HAMMITT, F. G., Ultrasonic-induced cavitation studies in lead–bismuth alloy at elevated temperatures, 20: 771 (NP-15558)
HAMMOND, J. P., Process for sintering uranium nitride with sintering aid depressant, 20: 806
HAN, InGun, Mass spectrometric measurement of ^{18}O in small carbon dioxide samples, 20: 243
HAND, J. E., Aerial radiological monitoring system, 20: 520 (CEX-59.4 (Pt.3))
HANEKOM, J., Cobalt-60 irradiation unit for agricultural research, 20: 697
HANNA, G. C., Survey of values of the 2200 m/s constants for four fissile nuclides, 20: 1164
HANNA, S. S., Gamma transitions in ^{57}Fe, 20: 1182
HANSON, J. E., Experimental studies of transient effects in fast reactor fuels. II., 20: 892 (GEAP-4804)
HANSON, W. C., Gamma-emitting radionuclides in Alaskan tundra vegetation 1959, 1960, 1961, 20: 525
HANSON, W. F., Studies of collective electron oscillations in metals by optical methods, 20: 1326 (ORNL-P-1600)
HAPPER, W., Spin, hyperfine structure, and new magnetic moment of 21-min ^{52m}Mn, 20: 1204
HARBOV, I., Electro- and cardiographic studies of radiation-treated patients with mammary gland cancer, 20: 213
HARDHAM, W. M., Photochemical, radiation chemical, and thermal modes of phenanthroxazoles, 20: 397
HARDIE, D., Slow-bend testing of hydrided zirconium, 20: 857
HARDY, Edward P. Jr., Prog. rpt. on fallout program, 6–9/65, 20: 521 (HASL-164)
HARDY, K. A., Energy dependence of free radical production in alanine, 20: 394
HARIHARAN, A. V., Preparation of metals by magnesium–zinc reduction. II., 20: 742 (ANL-7058)
HARRIS, D. R., Evaluation of cross sections of fissionable nuclides, 20: 1160 (WAPD-T-1847)
HARRIS, J. R., Magnetic moment of 99-kev first excited state of ^{195}Pt, 20: 1202
HARRISON, G. W. Jr., Radioprotection with AET–cysteine in Rhesus monkey, 20: 140
HARRISON, R. W., Prog. rpt. on refractory alloy corrosion loop program, 4/15–7/15/65, 20: 770 (NASA-CR-54477)
HARTMANN, G., Imaging properties of some microautoradiographic methods, 20: 13
HARTSHORNE, D. J., Deuterium–hydrogen exchange of muscle proteins, 20: 349
HARTWELL, Roy, Nuclear reactor, 20: 1425
HARVEY, Bernard G., Reactions (d,α) on ^{12}C, ^{14}N, and ^{16}O induced by 24-Mev deuterons, 20: 1211
HARVEY, J. A., Obtaining bursts of polarized neutrons with energies 10 to 700 kev, 20: 1134 (ORNL-P-1604)
HARVEY, R. R., Photoneutron cross sections of ^{6}Li, 20: 1217
HASENCLEVER, D., Testing of high-efficiency filters for collection of suspended particles, 20: 577 (CONF-650407, pp 805-13)
HASLAM, John L., Several dicarboxylic acids in water and D_2O, 20: 350
HASTE, G. R., Injection and accumulation—single-pass experiments (DCX-1), 20: 1269 (ORNL-3836, pp 1-14)
HATADA, Motoyoshi, Radiolysis of ethylene glycol diacetate, 20: 361
HAUGE, O. M., Engineering test program to investigate consequences of loss-of-coolant accident, 20: 567 (CONF-650407, pp 567-77)
HAVLOVIC, V., Dose of external γ radiation from deposited fission products, 1958 to 1963, 20: 533
HAVLOVIC, V., Results of systematic six years' measurement of atmospheric fallout, 20: 537
HAWKINS, C. S., Cobalt-60 irradiation unit for agricultural research, 20: 697
HAYASHI, Koichiro, Radiation-induced polymerization of cyclic dienes, 20: 383
HAYBRON, R. M., Excitation of quadrupole and octupole levels of ^{12}C, ^{16}O, and ^{40}Ca by 156-Mev protons, 20: 1215
HAYDEN, George A., Gamma irradiation effects on solid ribonuclease, 20: 53
HAYDEN, Page, Mechanisms of radiation resistance in pocket mice, 20: 114
HAYES, R. G., Paramagnetic resonance of alkyl radicals from dissociative electron attachment in γ-irradiated organic glass, 20: 371
HAYMAKER, Webb, Cerebral and cerebellar cortex following damage from ionizing particle radiation, 20: 68
HAYNIE, Thomas P., Treatment of malignant disease of thyroid, 20: 196
HEARN, A. C., Differential cross section for $e^+ + e^- \rightarrow W^+ + W^- \rightarrow e^- + \nu_e + \mu^+ + \nu_\mu$, 20: 1018
HEARNER, J. A., Iodometric analysis of mixtures of H_2O_2 and lower alkyl peroxides, 20: 248
HEDDLE, John A., Lack of interaction of x-ray- and neutron-induced chromosome breaks in barley, 20: 97
HEDGE, J. C., Thermal properties of fifteen refractory materials, 20: 878
HEINIGER, F., Density of states of chromium and its alloys, 20: 1330
HEINTZE, J., A search for the decay of $\pi^0 \rightarrow 3\gamma$, 20: 1007
HEINZE, D., Condensation of cellulose cross-linking agents by electron irradiation, 20: 358 (NP-tr-1299)
HEITNER-WIRGUIN, C., Kinetics of ion exchange in phosphonic resin Bio-Rex 63, 20: 263
HELANDER, Herbert F., Early effects of x irradiation on ultrastructure of gastric fundus glands, 20: 111
HELBIG, Herbert F., Measurements of resonant electron capture in close H^+-on-H collisions, 20: 971
HELLER, Peter, Nuclear resonance studies of magnetic critical fluctuations in MnF_2, 20: 1347
HELMIS, Guenther, Reactor with thickened fuel suspension circulated through tubes, 20: 1447
HELMLINGER, Harry C. Jr., Irradiation polymerization of compressed particulate trioxane, 20: 415
HENDEL, H., Prog. rpt. on electron cyclotron resonance plasma accelerator, 1–12/64, 20: 497 (AD-612175)
HENDERSON, D., Cell model for quantum fluids. III., 20: 1089
HENDERSON, R. W., Character of effluent material from a transient test of a nuclear rocket engine, 20: 566 (CONF-650407, pp 557-65)
HENDRICKER, David George, Metal carbonyl complexes of polycyclic phosphite esters, 20: 1561 (IS-T-31)
HENDRICKS, Herbert D., Bremsstrahlung produced by 0.75- and 1.25-Mev electrons incident on typical Apollo wall sections, 20: 1306 (NASA-TM-X-1140)
HENNIG, Robert J., Fast fuel test reactor, 20: 1546
HENNING, C. D., Transient heat transfer to laminar Bingham-plastic flow, 20: 490
HENNING, Hubert, Determination of water content of snow cover with γ rays, 20: 550
HERINGA, R. J., Mutation research in peas, 20: 81
HERNDON, Howard V., Unilinear displacement measuring apparatus, 20: 644
HERRMANN, W., Imaging properties of some microautoradiographic methods, 20: 13
HERSHKOWITZ, N., Efficient Moessbauer scattering technique, 20: 1250
HERSHKOWITZ, N., Moessbauer scattering in ^{169}Tm, 20: 1251
HESS, Walther, Polarization modifications of microwaves in penetration through low-pressure plasma, 20: 1292

HESTER, Ross E., Carbon-coated electron-transmission window, 20: 509
HICK, H., Semiconductor Compton spectrometer, 20: 1440
HICKING, Arobert, Medical findings in Marshallese people exposed to fallout: results from ten-year study, 20: 90
HIGATSBERGER, M. J., Semiconductor Compton spectrometer, 20: 1440
HILDEBRANDT, P. W., Uptake and retention of ^{95}Zr from certain foods, 20: 553 (BNWL-SA-293)
HILDRETH, William Wesley, Interaction of scalar gravitational waves with the Schwarzschild metric, 20: 957
HILL, E. D., Magnetic transitions in several rare earth metals, 20: 851
HILL, Helene Z., Decay of photoreactivability of the green-colony-forming system of Euglena gracilis, 20: 129
HILL, J. E., Auroral heights over Churchill, Manitoba, during International Quiet Solar Year, 20: 1097
HILL, R., Retention of oral dose of radioactive manganese in the pullet, 20: 29
HILL, Sarah L., Filter pack technique for classifying radioactive aerosols by particle size. IV., 20: 599 (NRL-6306)
HILLARY, J. J., Some experiments relating to behavior of gas-borne iodine, 20: 578 (CONF-650407, pp 830-52)
HILTON, D. A., Conversion of irradiated fuel swarf to stable ceramic suitable for long-term storage, 20: 1554
HIMMLER, Ulrich, Heat conductivity of neutron irradiated LiF, 20: 411
HINDS, S., Magnetic analysis of the $^{51}V(d,p)^{52}V$ reaction, 20: 1167
HINKLE, J. G., Prog. rpt. on application of gas-lubricated bearings to high speed turbomachinery, final, 6/65, 20: 458 (NYO-2512-15)
HINRICHSEN, P. F., Properties of the state in ^{31}P at 7.14 Mev, 20: 1203
HINTENBERGER, H., Radiogenic, spallogenic, and primordial rare gases in stone meteorites. III., 20: 956
HINTZ, Norton M., Nuclear structure information from two-nucleon transfer reactions, 20: 1232
HIRATA, A. A., K^0 production in $K^+ + n$ and $K^+ + p$ reactions, 20: 1010
HIRATA, Allan A., K+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
HIROTA, Kozo, Radiolysis of ethylene glycol diacetate, 20: 361
HO, James Chien-Ming, Measurements of magnetic hyperfine heat capacities and heat capacities of Cu–Mn alloys below 1°K, 20: 832 (UCRL-16180)
HODNETT, Ernest M., Prog. rpt. on isotope effect in study of chemical reactions, final, 1/64–5/65, 20: 347 (TID-22251)
HOEHLER, G., Conclusions of mathematical sciences. Vol. 37, 20: 924
HOFFMAN, H. W., Superheat with boiling alkali metals, 20: 482 (ORNL-P-1659)
HOFFMEISTER, Bernard, Equipment for installation and disassembly of apparatus in or out of reactor, 20: 1392
HOFMANN, H., Variant for mobile transfer containers for sealed γ emitters, 20: 160
HOKE, John H., Final rpt. on stress corrosion of high-strength steels, 6/65, 20: 772 (NYO-3257-1)
HOLLADAY, R. L., Prog. rpt. on high power density development, 3–5/65, 20: 1465 (GEAP-4894)
HOLLANDER, J. M., Very low-energy isomer in the decay of ^{99}Mo, 20: 1159 (UCRL-16306)
HOLLANDER, Jack M., Measurement of pair-production cross section near threshold, 20: 1214
HOLLISTER, Hal, Relationship of velocity of charged particle to its RBE, 20: 98
HOLMAN, K. L., Plutonium excretion following contaminated acid burns and prompt DTPA treatments, 20: 24 (RFP-640)
HOLMQUIST, C.-E., Hazards of tritium oxides induced in large heavy water reactor stations, 20: 927
HOLZER, R., Fission gas release from uranium dioxide, 20: 854
HOMEYER, W. G., Final safety and hazards report for the SNAP-15A generator, 20: 722 (GA-4554(Rev.))
HONDA, Yoshihide, Behavior and distribution of radionuclides in suspended matter in seawater. I., 20: 612
HONEYCUTT, C. R., Prog. rpt. on elevated-temperature fatigue data on refractory alloys in ultrahigh vacuum, 4–7/65, 20: 824 (NASA-CR-54458)
HONEYWELL, W. R., Flotation of uranium from Elliot Lake ores, 20: 450
HONSTEAD, J. F., Uptake and retention of ^{65}Zr from certain foods, 20: 553 (BNWL-SA-293)
HORESOVSKY, C., Measurement of soft β-radiation in biological material with aid of liquid scintillators. II., 20: 253
HORNE, R. A., Electron- and proton-transfer by Grotthuss mechanism in aqueous solution and in biological systems, 20: 340
HORSTMAN, Herold R., Polytrifluorocarbon adhesive comprising an α-carboxymethylacrylate coamino-polyamide resin, 20: 1579
HORSTMANN, M., Measurement of cross section for elastic electron scattering in polycrystalline Al layers at different temperatures, 20: 981
HORTON, N. R., Computation of potential radiological hazards from reactor accidents, 20: 1348 (CONF-650407, pp 1057-70)
HORYN, R., Phase equilibria in UO_2–Sc_2O_3 and ThO_2–Sc_2O_3 systems, 20: 839
HORYN, R., Phase equilibria in the Y_2O_3–Sc_2O_3 system, 20: 840
HORYN, R., Phase equilibria in CaO–Sc_2O_3 system, 20: 841
HOUGH, WALTER A., Gamma attenuation by loblolly pine wood, 20: 1313
HOUGHTON, A., Nucleation of superconductivity in wedge geometry, 20: 1123
HOWARD, D. E., Operating experience at Saxton, 20: 1508
HOWARD, John C., Nitride and oxide bands of molybdenum, 20: 965
HRIZO, J., Defect structure and electrical conductivity of ThO_2–Y_2O_3 solid solutions, 20: 843
HUART, R., Conservation and stability of labeled macromolecules, 20: 2 (EUR-2419.f)
HUBER, Beano, Fuel element for nuclear reactor, 20: 1446
HUET, Andre, Suspension for heat exchanger units of reactor connected to waste-heat steam generator, 20: 1525
HUET, Henri, Production of U by Mg reduction of UF_4, 20: 761
HUET, J.-J., Powder-agglomeration method for fabrication of spherical fuel particles, 20: 793
HUET, J.-J., Vanadium as diffusion barrier between aluminum and uranium, 20: 855
HUETTER, T., Analysis of 3587 τ^+ decays, 20: 1011
HUGHES, Benjamin Glenn, Some polynuclear tantalum halides and their oxidized derivatives, 20: 337
HUGON, J., Atmospheric diffusion experiments on French nuclear sites, 20: 540 (CONF-650407, pp 394-404)
HULET, K., Search for spontaneously fissioning isomer of ^{242}Am formed by thermal neutron capture, 20: 1191
HULL, Pieter L., Remote porosimeter, 20: 622 (LA-DC-7149)
HULSE, E. V., Mucus-depleting action of bile in small intestine of irradiated rats, 20: 78
HUMBLE, J. G., Clinical application of bone marrow grafts, 20: 134
HUNT, Stanley Ernest, Radiation detector and discriminator utilizing semiconductor solid-state detector, 20: 691
HUNTLEY, W. R., Prog. rpt. on SNAP-8 corrosion program, 5/65, 20: 773 (ORNL-3859)
HUSAK, Vaclav, Ionizing radiation dose units, 20: 611
HUSCHKA, Hans, Metallographic preparation of nuclear fuel particles, 20: 797
HUSSEINY, Mohamed Mamdouh, Sterilization of the navel orangeworm by γ radiation, 20: 83
HUTCHEON, J. M., Graphite for the commercial AGR, 20: 1497
HVIDT, Aase, pH dependence of hydrogen–deuterium exchange of proteins, 20: 419
HYMAN, George A., Management of Hodgkin's disease coexistent with pregnancy, 20: 209

I

ICONOMOU, N., Influence of radioactive rays on pharmaceuticals. III., 20: 713
IMAI, Masazo, Properties of graft copolymerized cellulose fiber. II., 20: 363
IMAI, Ryokichi, Dungeness B appraisal, 20: 1501
IMAI, Ryokichi, Engineering problems of power reactor fuel. I., 20: 1496
IMRIS, D., Reflexion spectra of UO_2 prepared from U_3O_8 calcinated under various conditions, 20: 318
IMRIS, P., Reflexion spectra of UO_2 prepared from U_3O_8 calcinated under various conditions, 20: 318
IMRISOVA, D., Pyrolysis products of uranium trioxide monohydrates. II., 20: 870
INCROPERA, F. P., Flow transition phenomena in subsonic plasma jet, 20: 1084 (SU-247-9)
INGLES, Ove, Concentrations of inorganic constituents of the teeth, 20: 27
INOENUE, E., Diffusion length for arbitrarily anisotropic scattering, 20: 1137
INOUE, Yoshinori, Skin contamination by radioactive isotopes. III., 20: 40
INSINGER, Francois Gerard, Rotating plasma experiment, 20: 1266 (NP-15450)
INUKAI, Kan, Radiation-induced addition reaction of ethers to fluorine-containing olefins, 20: 395
IOVA, I., Hollow-cathode effect in cesium vapor, 20: 1087
ISBIN, Herbert S., Critical two-phase flow, 20: 488
ISHII, Mitsuru, Electron beam electron melting of refractory metals. III., 20: 858
ISOYA, Toshiro, Radiolysis of ethylene glycol diacetate, 20: 361
ITOH, Koichi, Proton-deuteron exchange of the radical in irradiated single crystals of DL-aspartic acid, 20: 373
IVANOV, A. E., Behavior in lungs of ($^{144}CeF_3$) with intratracheal introduction, 20: 38
IVANTER, I. G., Four-fermion interactions and baryon masses, 20: 1074
IVINS, Richard O., Calculation demonstrating effect of Zr–H_2O reaction on analysis of loss-of-coolant accident, 20: 582 (CONF-650407, pp 938-

69)
IWABUCHI, Masaki, Effect of mitomycin-C on the frequency of chromosome aberrations produced by x rays, 20: 71
IWATA, Hideo, Quantitative analysis of yttrium in steel by solution spectrographic analysis, 20: 266

J

JABSEN, Felix S., Reactor fuel hold-down assemblies, 20: 1431
JACKSON, R. J., Technique for plutonium-electrolytic swab etching, 20: 751 (RFP-543)
JACOBS, D. G., Desorption of radioiodine from clays, 20: 600 (ORNL-P-1581)
JACOBS, James P., Pregnancy complicating carcinoma of cervix: review of 33 cases, 20: 201
JACZ, K., Effect of ionizing radiation on biological activity of gliomas, 20: 101
JAECKS, Duane Harvey, Production of metastable 2S hydrogen atoms in proton–rare gas collisions, 20: 982
JAEGER, K., Gas chromatographic determination of deuterium content in D_2O, 20: 265
JAEGERHUBER, P., Radioactivity measurements in foodstuffs. II., 20: 524
JAFFE, Joseph, Catalyst composition consisting of a plurality of oxides supported on zirconia and/or hafnia base and process of preparing same, 20: 343
JAGET, Charles W., Several dicarboxylic acids in water and D_2O, 20: 350
JAIN, S. C., Evidence of different types of F centers from thermoluminescence studies in x-irradiated alkali halides. I., 20: 903
JAMES, Thomas G., Bremsstrahlung produced by 0.75- and 1.25-Mev electrons incident on typical Apollo wall sections, 20: 1306 (NASA-TM-X-1140)
JANZ, George J., Prog. rpt. on electrolytes in polar organic solvents, annual, 10/65, 20: 1565(R) (RPI-1999-6)
JARRETT, A. A., Sodium fires and the release characteristics of particulates and fission products, 20: 558 (CONF-650407, pp 94-117)
JEANJEAN, J., Current spark chamber used as several-hundred-channel ladder counter, 20: 653 (LAL-1143)
JEDRZEJEC, H., Measurement of velocity of plasma in plasmotron nozzle, 20: 501
JELINEK, F. J., Magnetic transitions in several rare earth metals, 20: 851
JELINEK, T. M., Studies of collective electron oscillations in metals by optical methods, 20: 1326 (ORNL-P-1600)
JELLISON, J. C., Cryogenic aspects of Project Sherwood magnets and magnet materials, 20: 1264 (NBS-8843)
JENKINS, T. L., Cross sections for $\nu_e + p \rightarrow \beta^+$ and $\nu_e + D \rightarrow 2n + \beta^+$, 20: 993 (COO-818-70)
JENKNER, F., Comparison between radiological and rectosigmoidoscopic pictures after radiotherapy of cervic carcinoma, 20: 193
JENNESS, R. G., Two-piece manipulator boot, 20: 477 (ORNL-P-1385)
JENNINGS, E. R., Sterilization of surgical sutures: comparison of heat and irradiation, 20: 703
JENQUIN, U. P., PuO_2–UO_2 experiment in the EBWR, 20: 1457 (BNWL-126)
JENSEN, Ronald P., Several dicarboxylic acids in water and D_2O, 20: 350
JHINGAN, M. L., Reaction (d,p) of ^{23}Na in energy range from 1.0 to 2.5 Mev, 20: 1185
JIBUTI, R. I., Velocity-dependent potential and deuteron photodisintegration at high energies, 20: 1195
JOHN, R. R., Experimental performance of high specific impulse arc-jet engine, 20: 500
JOHN, W., Search for spontaneously fissioning isomer of ^{242}Am formed by thermal neutron capture, 20: 1191
JOHNS, W. L., Technique for plutonium-electrolytic swab etching, 20: 751 (RFP-543)
JOHNSON, B. E., Triprolidine and response of skin to uv radiation, 20: 132
JOHNSON, D. S., Electron- and proton-transfer by Grotthuss mechanism in aqueous solution and in biological systems, 20: 340
JOHNSON, Dale E., Method of making nuclear fuel compact, 20: 804
JOHNSON, Dale E., Method of making nuclear fuel compact, 20: 808
JOHNSON, G. E., Moessbauer effect of ^{57}Fe in cobalt single crystal, 20: 1198
JOHNSON, J. M., Electron microprobe analysis of highly radioactive samples, 20: 224 (CNLM-6352)
JOHNSON, R. L., Analysis of excursion behavior of highly enriched plate-type D_2O-moderated core in SPERT II, 20: 1412 (IDO-17109)
JOHNSON, W. C. Jr., Analysis for microgram quantities of thorium in plutonium, neptunium, and uranyl nitrate solutions, 20: 242
JOHNSTON, Charles, Nuclear fuel assembly, 20: 1442
JOINER, W. C. H., Magnetic instabilities and flux annihilation in grossly inhomogeneous superconductors, 20: 1132
JONES, C. H., Obtaining isodose curves using film dosimetry, 20: 671
JONES, C. M., N-d scattering–vector polarization of recoil deuterons from polarized neutron beam, 20: 997 (ORNL-P-1607)
JONES, Francis Robert, Improvements in and relating to steam generators, 20: 1517
JONES, Gary E., Emanation of radon 222 from soils and its use as tracer, 20: 528
JONES, J. M., Notes on plasma oscillations, 20: 1254 (ARL-65-151)
JONES, M. T., Anomalous deuterium hyperfine splittings, 20: 315
JORASZ, Elzbieta, Chemical protection from ionizing radiation. IV., 20: 131
JORDAN, Lawrence Marcellus, Velocities of 4-Bev/c pions and 8-Bev/c pions, kaons, and protons, 20: 1117
JORDAN, Thomas F., Conservation laws implied by Lorentz invariance and conservation of spin, 20: 1068
JOSA, J. M., Natural leaching of uranium minerals, 20: 440
JUDD, William R., Conference on stress in the earth's crust, Santa Monica, Calif., 6/63, 20: 513
JULIAN, Frederick Arthur, Linear accelerators of tandem type, 20: 948
JULIANO, Jose O., Activation analysis by photoneutron counting, 20: 270

K

KABACHNIK, N. M., M1 excitation of ^9Be nucleus, 20: 1222
KADLECOVA, Libena, Determination of nanogram amounts of cesium by a concentration-dependent distribution method, 20: 250
KADYK, J. A., K^* production in $K^+ + n$ and $K^+ + p$ reactions, 20: 1010
KADYK, John A., Diffraction scattering of virtual pions and the A_1 enhancement, 20: 1008
KADYK, John A., K^+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
KAHALAS, S. L., Interpretation of early magnetic transients caused by high-altitude nuclear detonations, 20: 1102
KAIMAN, S., Flotation of uranium from Elliot Lake ores, 20: 450
KAISER, Rudolf, Radiation damage on germanium, silicon, and III-V semiconductors, 20: 908
KALAYDZHIEV, Vl., Regulations governing work with radioactive substances, 20: 602 (JPRS-31747)
KALAYDZHIEV, Vl., Standards of radiation safety, 20: 155 (JPRS-31646)
KALINKIN, B. N., Matrix elements for inelastic scattering of heavy particles. II., 20: 1054 (JINR-P-2328)
KALISH, Y., Proposal for new type of scintillation γ camera, 20: 668
KALUSCHE, H., New instruments for measurement of neutron flux density and the radiation survey at nuclear reactors, 20: 1359
KAMMERER, O. F., Superconductivity in tungsten films at temperatures near 4°K, 20: 813 (BNL-9479)
KAMPBELL, Donald Henry, Cerium, Fe, and Mn sorption by soil colloids and uptake by plants, 20: 19
KAMPER, R. A., Cryogenic aspects of Project Sherwood magnets and magnet materials, 20: 1264 (NBS-8843)
KAMPFE, William R., Re-entry overpressure shock simulation test, 20: 462 (SC-DC-65-1554)
KANCHELI, O. V., Broken Schwinger symmetry W_3, 20: 1075
KANEKAR, C. R., Proton magnetic resonance spectra of pyridine N-oxide, 4-substituted pyridine N-oxides, 20: 301
KAPLAN, S., Analogy between variational principles of reactor theory and those of classical mechanics, 20: 1136
KAPLAN, S., Invariant imbedding and integration techniques of reactor theory, 20: 1415
KAPLAN, S. I., Behavior of iodine released in containment vessels, 20: 424
KAPLAN, Selig N., Electron capture by high-energy deuterons in gases, 20: 974
KAPRIELIAN, Z. A., Cherenkov radiation in inhomogeneous periodic media, 20: 979
KARGIN, V. A., Action of fast electrons on structure of polyvinylchloride, 20: 400
KARPLUS, M., Exchange reactions with activation energy. I., 20: 312
KARPOV, V. L., Characteristics of radiation crosslinkage of polyolefins and their copolymers in N_2O medium, 20: 402
KARPOV, V. L., Diffusion of gases in polymers exposed to ionizing radiation, 20: 407
KARPOV, V. L., Dynamic determination of elasticity constants of polymeric materials irradiated by γ rays and fast electrons, 20: 406
KARWAT, H., Influence of activity release and removal effect on escape of fission products from double containment system, 20: 584 (CONF-650407, pp 984-99)
KASAI, Paul H., Electron spin resonance studies of γ- and x-ray-irradiated zeolites, 20: 375
KASTEN, Paul R., Design concepts for core structure of molten salt experimental reactor, 20: 1423
KATMAN, Thomas Sidney, Proton-gamma angular correlations in the $^{12}C(d,p)^{13}C$ reaction at low energies, 20: 1242
KATOH, Kazuaki, Greening's treatment of saturation characteristics of

parallel-plate ionization chambers, 20: 670
KATSANOS, N. A., Post-irradiation reactions in neutron-irradiated liquid bromobenzene, 20: 376
KATZ, N. H., Magneforming process for fabrication of thin-wall tungsten cylinders, 20: 781 (AI-65-12)
KAUFMAN, Aaron, Radiocarbon chronology of Lake Lahontan and Lake Bonneville II, Great Basin, 20: 546
KAUFMAN, Alfred Michael, Regge poles and the semiclassical approximation, 20: 1079
KAUFMAN, W. C., Prediction of nearest safe distances for thermal radiation of nuclear weapons, 20: 614
KAUL, C. N., Propagation of hydromagnetic shocks, 20: 1092
KAUN, K.-H., Coincidence measurements in decay of ^{187}W, 20: 1179
KAUN, K.-H., Decay of ^{181}Hf, 20: 1177
KAUN, K.-H., Decay $^{153}Sm(\beta^-)^{153}Eu$, 20: 1178
KAWAI, Hiroshi, Behavior and distribution of radionuclides in suspended matter in seawater. I., 20: 612
KAWASAKI, Sussc, Resonance of phase oscillations in a synchrotron, 20: 941
KAZANAS, N., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
KAZNOFF, A. I., Diffusion and interactions in the urania–tungsten and urania–molybdenum systems, 20: 339
KECKI, Zbigniew, EPR spectra of γ-irradiated single crystals of β-succinic acid, 20: 389
KEEFER, D., Modulus effects in metals after low-temperature electron irradiation, 20: 897
KEENAN, T. K., Lattice constants of some alkali metal actinyl(V) compounds, 20: 305
KEENER, R. B., Radioactive layer over Barrow, Alaska, attributed to Chinese nuclear test of October 16, 1964, 20: 531
KEIL, Thomas H., Excited states of solid Ar : H. II., 20: 1337
KELLER, Donald L., Radiation stability of uranium mononitride, 20: 888 (BMI-1731)
KELLER, George H., Nuclear density probe for in-place measurement in deep-sea sediments, 20: 551
KELLER, M., Dose burden in x-ray diagnosis, 20: 182
KELLER, Nancy, Thorium-228 decay series in adult beagles: ^{224}Ra, ^{212}Pb, and ^{212}Bi in blood and excreta, 20: 42
KELLER, W. E., Narrow channel flow, 20: 1119 (LA-DC-7357)
KELLEY, G. G., High-current ion-beam production and injection, 20: 962 (ORNL-3836, pp 74-80)
KELLY, A., Fiber-strengthened materials, 20: 884
KEMMLER, Sibylle, Crystal structure of $LiUO_3$, 20: 334
KEMPE, L. L., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
KENADY, Sarah E., FLAME master control system, 20: 1421 (AD-611775)
KENDRICK, E. D., Prog. rpt. on Elk River Reactor operations, semiannual, 7–12/64, 20: 1453 (ACNP-65532)
KENNEDY, T. S., Nutritional value of foods treated with γ radiation. II., 20: 50
KENNEL, Charles Frederick, Low-frequency stability of spatially non-uniform plasmas, 20: 1301
KENNEY, Edward Stephen, Decay of ^{82}Br, 20: 1243
KERDELLEAU, Jean, Ultrasonic copper and brass decontamination study, 20: 430 (CEA-R-2823)
KERN, Fred R., Prog. rpt. on two-phase momentum flux and design of a heat pipe, 6/65, 20: 483 (TID-22224)
KETOVA, L. A., Determination of cesium in magnesium alloys by means of a vanadium(II) salt, 20: 274
KEUFFEL, Jack. W., Muon capture in ^3He, 20: 1209
KHOMCHICK, L. M., Organization of centralized removal of radioactive wastes from sites of their accumulation, 20: 1553
KHOMIKOVSKII, P. M., Radiation polymerization of diketene in solid and liquid states, 20: 398
KHOPKAR, P. K., Aqueous chemistry of hafnium(IV) solvent extraction and ion exchange studies, 20: 260
KHOZE, V. A., Photon emission in electromagnetic annihilation of heavy particles, 20: 1024
KHRIPCHENKO, I. P., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
KHRONONULO, Yu. G., Some questions of the theory of two-photon processes, 20: 1000
KHURI, N. N., Forward scattering amplitude and univalent functions, 20: 1065
KIBBEY, A. H., Two-step process for decontaminating low-radioactivity-level process waste water, 20: 1549 (ORNL-3811)
KIM, C. W., Theory of muon capture with initial and final nuclei treated as elementary particles, 20: 1207
KIMURA, Yuichiro, Behavior and distribution of radionuclides in suspended matter in seawater. I., 20: 612
KINCHIN, G. H., Reactivity measurements in HECTOR, 20: 1543
KINGSLEY, R. S., Solvent extraction recovery of Am with DBP, 20: 436 (RL-SEP-518)
KINOSHITA, Hideo, Research in uranium refining, 20: 441
KINOSHITA, T., Forward scattering amplitude and univalent functions, 20: 1065
KIRSCH, M., Variant for mobile transfer containers for sealed γ emitters, 20: 160
KISHII, Toru, Thermal glow of some commercial glasses irradiated by uv, x- and γ-rays, 20: 382
KISIELESKI, Walter E., Tumor induction in mice by radioactive thymidine, 20: 66 (TID-22292)
KITAHARA, Keido, Radioactivity in rain water, settled dust, and activated sludge observed in Kagoshima District, 20: 534
KJEMS, Ebbe, Radiation resistance of substrains from Streptococcus faecium, 20: 69
KLEIMA, Dirk, Representation theory of the group SU_3, 20: 1056 (NP-15536)
KLEIN, D. J., High-temperature thermal diffusivity measurements by flash technique, 20: 823 (LA-DC-7456)
KLEIN, Erich, Goiters during the years of growth, 20: 185
KLEIN, Erich, Treatment of hyperthyroidism, 20: 181
KLEIN, Lawrence T., Effects of probability of launch success on long-term usage of radioisotopic SNAP units, 20: 725
KLEIN, R., Microwave observation of proximity effects in magnetic fields, 20: 1124
KLOCKOW, D., Temperature dependence of fading effect in semiquantitative autoradiography by ring-oven method, 20: 251
KLOSTERMEYER, J., Experimental results on dynamics of the F region, 20: 1099
KLOTZ, H.-D., Behavior of electrons in stratified low-pressure discharge, 20: 1086
KLOTZ, R. J., Analysis of fission product activity effects for Elk River Reactor, 20: 1547 (CEND-512)
KLUG, H., Lymphatic reaction following partial-body irradiation, 20: 142
KLUGE, Hans, Boiling water nuclear reactor producing superheated steam, 20: 1522
KNECHTEL, Guenther, Electrical polarization in lead silicate glass after x irradiation, 20: 410
KNEIP, George Dewey Jr., Method of increasing critical current density of hard superconducting alloys and the products thereof, 20: 1121 (AI-Trans-97)
KNIGHTON, J. B., Preparation of metals by magnesium–zinc reduction. I., 20: 741 (ANL-7057)
KNIGHTON, J. B., Preparation of metals by magnesium–zinc reduction. II., 20: 742 (ANL-7058)
KNIGHTON, J. B., Solubility of uranium and plutonium in cadmium–zinc–magnesium melts, 20: 447
KNOBELOCH, G. W., Precision assay by fission counting, 20: 228 (LA-DC-7439)
KNOLL, G. F., Calculated γ photofractions for well-type scintillation detectors, 20: 676
KNOP, Oswald, Determination of crystal structure of $Et_2Ti_2O_7$ by x-ray and neutron diffraction, 20: 298
KNORRE, V. L., Effect of deuterium substitution on temperature of helix-coil transition in DNA, 20: 14
KNOTIK, K., Production of small uranium carbide spheres from melts and melt suspensions, 20: 792
KNUDSON, A. R., Tables of spherical Hankel functions of imaginary argument, 20: 735 (NRL-6288)
KNY, L., Radioactive pharmaceuticals, 20: 200
KOBE, Donald H., Criteria for best Bogoliubov quasiparticle, 20: 1126
KOBISK, E. H., Prog. rpt. on isotopes target program, 10/63–12/64, 20: 696 (ORNL-3829)
KOBZAREV, I. Yu., Ademolio-Gatto theorem and supercharged particles, 20: 1072
KOCH, Edgar, Circuit arrangement for portable radiation detection instruments, especially dose-rate meters, 20: 683
KOCH, G., Reprocessing of nuclear fuels by liquid-liquid extraction with quaternary ammonium nitrates, 20: 446
KOCH, R., ESR investigations of uv- and x-irradiated homocysteine-thiolactone, 20: 386
KOEHLER, J., Stage III annealing in proton-irradiated noble metals, 20: 902
KOENIG, H., Radiogenic, spallogenic, and primordial rare gases in stone meteorites. III, 20: 956
KOGA, Taeko, Behavior and distribution of radionuclides in suspended matter in seawater. I., 20: 612
KOGAN, R. M., Determination of water supplies in snow deposits by aerial γ exposure, 20: 549
KOIZUMI, Tetsuya, Structure of oxide films formed on Zr surface, 20: 778
KOKUBUN, Susumu, Dynamic behavior and north–south conjugacy of geomagnetic bays, 20: 1106
KOKUBUN, Susumu, Geomagnetic pulsation pc-5 in and near auroral zones, 20: 1105

KOLDE, H. E., Quality control of radioactivity-counting systems, 20: 655 (PHS-999-RH-15)
KOLDOBSKAJA, F. D., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
KOLLER, Alois, Device for generation of a plasma jet, 20: 503
KOLLER, E. L., Analysis of 3587 τ^+ decays, 20: 1011
KOLLIE, T. G., Pulse-heating calorimetric technique for measuring specific heat of electrical conductors and its application to pure iron from 100 to 1400°C, 20: 827 (ORNL-P-1670)
KOLLMER, W. E., Biological behavior of radiostrontium in rats in course of lactation, 20: 35
KOMAR, A. P., Photoneutron cross section of ^{12}C, 20: 1196
KONDO, Sohei, RBE of 14.1-Mev neutrons in killing dormant silkworm eggs, 20: 72
KONOBEEV, Yu. V., Theory of electron-excitation energy migration in molecular crystals, 20: 1325 (NP-15453)
KOO, Frank S., Resonance in radiation effects, 20: 46 (PRNC-40)
KOONTZ, R. L., Sodium fires and the release characteristics of particulates and fission products, 20: 558 (CONF-650407, pp 94-117)
KOPP, P. M., Protection of aqueous polymer solutions by colloidal sulfur, 20: 137
KORNET, F. A., Degradation of C-816 and C-437 with fluorine, 20: 346 (GAT-L-420)
KOSEK, Stanislaw, EPR spectra of γ-irradiated single crystals of β-succinic acid, 20: 389
KOSS, P., Production of small uranium carbide spheres from melts and melt suspensions, 20: 792
KOSTENKO, C., Thermal properties of fifteen refractory materials, 20: 878
KOSTIN, M. D., Collision density of hot atoms, 20: 966
KOVBA, L. M., New compounds of rare earths with strontium and barium oxides, 20: 302
KOVBA, L. M., New compounds of rare earths with lithium, 20: 303
KRAEMER, Juergen, Device for detection of defective fuel elements in nuclear reactors, 20: 1396
KRAMER, P., Symmetry groups of simple three-particle system, 20: 1058
KRASAVAGE, W., Dose and energy among major organs of a beagle cadaver, 20: 604
KRAUSE, W., Dose burden in x-ray diagnosis, 20: 182
KREJCI, V., Continuous transition from backward to forward ionization wave, 20: 1290
KRESNIN, A. A., Theory of polarization phenomena in quantum electro-, 20: 996 (NP-15204)
KRESS, T. S., Model for fission product transport and deposition under isothermal conditions, 20: 1349 (ORNL-TM-1274)
KRIEGEL, H., Biological behavior of radiostrontium in rats in course of lactation, 20: 35
KRISHNAMURTHI, S., Evaluation of treatment of advanced primary and secondary gingival carcinoma, 20: 175
KRISTAL'NYI. E. V., Gamma-induced polymerization of isobutylene in presence of solids, 20: 403
KRITCHEVSKY, David, Influence of D_2O on plaque size of western equine encephalitis virus, 20: 39
KRIVISKII, A. S., Mutagenic effect produced by irradiation of an extracellular phage, 20: 80
KROEPFL, Hans, Fuel element for nuclear reactor, 20: 1446
KROPSCHOT, R. H., Cryogenic aspects of Project Sherwood magnets and magnet materials, 20: 1264 (NBS-8843)
KRUGLYAKOV, I. O., Use of cybernetics in development of radiation therapy, 20: 167 (N64-20943, pp 35-46)
KRUSE, C. L., Radioactivity measurements in foodstuffs. II., 20: 524
KRUSKAL, M., Convergence of iteration based on Prigogine's generalized variational principle, 20: 1083 (MATT-368)
KRUZIC, T. P., Prog. rpt. on Elk River Reactor operations, semiannual, 7–12/64, 20: 1453 (ACNP-65532)
KRZECHZKOWSKI, R. A., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
KUBO, Toruichiro, Shrinkage of powder compacts during sintering, 20: 755 (IS-Trans-20)
KUCHOWICZ, Bronislaw, Neutrinos in superdense matter. II., 20: 951
KUDAKA, Katsuya, Shrinkage of powder compacts during sintering, 20: 755 (IS-Trans-20)
KUETHER, Frederick W., Integrated neutron flux indicator, 20: 684
KUHUSHKINA, V. A., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
KULIKOV, A. V., Photoneutron cross section of ^{12}C, 20: 1196
KULKARNI, V. G., Lifetimes of positronium in polyethylene irradiated by γ rays, 20: 1002
KUMPF, Hermann, Fuel element for nuclear reactor, 20: 1446
KUNKEL, W. P., Fission product retention and plating behavior in liquid sodium systems, 20: 557 (CONF-650407, pp 73-93)
KUNKEL, Wulf B., Interchange stabilization by incomplete line-tying, 20: 1280 (UCRL-16055)
KUNZ, William Edward, 35-Gc linear bunching accelerator for electrons, 20: 942
KUPP, R. W., Fission product release program, 20: 571 (CONF-650407, pp 641-7)
KUPRIANOFF, I., Control and identification of irradiated foods, 20: 709
KURAEV, E. A., $K \to 2\pi$ decay and SU(3) symmetry, 20: 1022
KURIHARA, Yasuo, Deuterium enrichment by dual temperature exchange reaction between hydrogen and water, 20: 264
KURILENKO, A. I., Dynamic determination of elasticity constants of polymeric materials irradiated by γ rays and fast electrons, 20: 406
KUZMA, I., Effect of ionizing radiation on biological activity of gliomas, 20: 101
KUZNETSOV, G. I., Integral representations of relativistic amplitudes in the nonphysical region, 20: 1053 (JINR-P-2321)
KUZNETSOV, I. V., Correlation between physical theories and the development of contemporary elementary particle physics, 20: 1033
KUZNETSOV, I. V., Philosophical problems of elementary particle physics, 20: 1032
KVALE, E., Half-life and decay properties of ^{78}Ge, 20: 1169
KVAM, Donald J., Waste management practices at Lawrence Radiation Laboratory, Livermore, 20: 1552 (UCRL-14320)
KWOK, J., Infrared spectra and intensity enhancements in solutions of hydrogen halides in liquid xenon, 20: 311
KYRS, Miroslav, Determination of nanogram amounts of cesium by a concentration-dependent distribution method, 20: 250
KYRS, Miroslav, Method of concentration-dependent distribution in quantitative use of radioisotopes. I., 20: 245

L

LADA, Witold, Absolute measurements of radioactivity with 4π counter, 20: 666
LADDAGA, M., Effect of hyperoxygenation on radiosensitivity of hepatic tissue, 20: 95
LADEMANN, W., Gonad dose in radiation therapy of non-tumorous diseases, 20: 206
LAFONTAINE, A., Control and identification of irradiated foods, 20: 709
LAFONTAINE, I., Preparation and coating of spherical particles of PuO_2 and $(U–Pu)O_2$ mixtures, 20: 747 (EURAEC-1391)
LAGERQUIST, C. R., Plutonium excretion following contaminated acid burns and prompt DTPA treatments, 20: 24 (RFP-640)
LAGU, A. V., Mass quantization of half-spin particles, 20: 1059
LAGU, R. G., Lifetimes of positronium in polyethylene irradiated by γ rays, 20: 1002
LAI, Tsai-teh, Polarography of uranyl-malate complexes at moderately low temperature, 20: 295
LAIRD, A. Thomas, Experience with chlormerodrin-Hg brain scan, report of 163 cases, 20: 178
LAKIN, W., Singularities in eigenfunctions, 20: 964
LALLEMENT, R., Resistivity and magnetic susceptibility of cerium nitride at low temperature, 20: 1332
LANE, R. K., Control rod analysis—effect of mesh spacing and boundary condition location in both one- and two-dimensional analysis, 20: 1464 (GAMD-6364)
LANG, J. I., Thermal properties of fifteen refractory materials, 20: 878
LANGE, Hans, Heterogeneous, thermal nuclear reactors for insertion into bituminous deposits reached by bore holes, 20: 1526
LANGSTON, S. A., Perovskite-type rare-earth niobates and tantalates, 20: 844
LANZO, Chester D., Simulated fuel assembly, 20: 1398
LAPCHENKO, S. N., Condition of carcinomatous laryngeal mucosa after x-ray therapy, 20: 166 (N64-20943, pp 1-8)
LAPERISHVILI, L. V., Broken Schwinger symmetry W_3, 20: 1075
LARSEN, P. S., Influence of axially non-uniform heat flux on DNB, 20: 492
LARSON, H. A., Analysis of excursion behavior of highly enriched plate-type D_2O-moderated core in SPERT II, 20: 1412 (IDO-17109)
LASHINSKY, H., Prog. rpt. on plasma instabilities, 6–8/65, 20: 1278 (TID-22273)
LASHKAROV, G. V., Electric properties of Pr_2Se_2 and Nd_2Se_2, 20: 868
LASKA, L., Continuous transition from backward to forward ionization wave, 20: 1290
LATARJET, R., Prog. rpt. on interaction of radiation with DNA, annual, 1964, 20: 45 (EUR-2471. f)
LATTEIER, Karl K., Radiation in pregnancy, 20: 195
LATYSHEV, L. A., Temperature fields in sub-cooled fluid in nucleate boiling, 20: 485 (ANL-Trans-225)
LAUBEN, G. N., Sodium fires and the release characteristics of particulates and fission products, 20: 558 (CONF-650407, pp 94-117)
LAUER, H., Determination of anodic hydrogen–deuterium separation factors on noble metal electrodes, 20: 418
LAUER, K. F., Determination of lutetium in Al–Lu alloy, 20: 247
LAUER, K. F., Polarographic determination of elements of nuclear interest.

L., 20: 249
LAURER, Gerard, Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1, Pt. I)
LAUTERJUNG, K. H., Difference spectrum of α particles after β decay of $^{8}Li \rightarrow {}^{8}Be$, 20: 1176
LAVERICK, C., Superconducting minimum-B magnet, 20: 1279 (UCRL-14233)
LA VERNE, Melvin E., New similarity parameter for correlation of jet pump cavitation, 20: 460 (ORNL-P-1447)
LAVIE, J. M., Atmospheric release limitation techniques in case of reactor accident, 20: 585 (CONF-650407, pp 1000-14)
LAVIE, J. M., French safety research program on fission product behavior, 20: 568 (CONF-650407, pp 578-86)
LAWIN, H., Mass spectrometric separation of fission products, 20: 434 (JUL-248-NP)
LAZZARINI, E., Delayed neutron precursors in recombiner of L54M reactor, 20: 1539
LEADBETTER, A. J., Thermodynamic and vibrational properties of H_2O ice and D_2O ice, 20: 1341
LEARY, J. A., Fused-salt electrorefining of molten plutonium, 20: 443
LE BRIS, Jean, Method for leaching uranium-containing ores, 20: 451
LECLOU, Andre, Mechanical coupling device, especially for pressure vessels, 20: 1374
LEDOUX, L., Conservation and stability of labeled macromolecules, 20: 2 (EUR-2419.f)
LEE, C. R., Research on concrete structures in nuclear engineering, 20: 1312
LEE, Jong S., Food preservation by irradiation—present status, 20: 719
LEES, J., Moessbauer effect in ^{119}Sn, 20: 1335
LEFFINGWELL, T. P., Radioprotection with AET–cysteine in Rhesus monkey, 20: 140
LEFRANCOIS, J., Current spark chamber used as several-hundred-channel ladder counter, 20: 653 (LAL-1143)
LEGAR, F., Planning of n-p scattering experiments for determining the most probable set of phase shifts, 20: 994 (JINR-P-2332)
LEHMER, Wilhelm, Process and means for removing radioactive components from gases and gaseous mixtures, 20: 1397
LEINHARDT, T. E., Electrical resistance of cerium as determined by temperature and crystal structure, 20: 829 (TID-22275)
LEINHARDT, T. E., Temperature dependence of the optical reflectivity of cerium metal, 20: 917 (TID-22277)
LEITH, C. E., Convection in a six-level model atmosphere, 20: 517 (UCRL-12415-T)
LELE, S. V., Mass quantization of half-spin particles, 20: 1059
LELLOUCHE, Gerald S., Safety considerations based on design experiences in BNL settled-bed fast reactor concept, 20: 1456 (BNL-9475)
LEMESLE, Georges, Belt restraint system for moderator-reflector structure of nuclear reactor, 20: 1405
LEMESLE, Georges, Handling apparatus for gas-cooled nuclear reactor installation, 20: 1399
LEMESLE, Georges, Loading machine for nuclear reactors channels, 20: 1391
LEMESLE, Georges, Solid construction of moderator for nuclear reactors, 20: 1390
LEMMON, Richard M., Radical termination mechanisms in radiolysis of crystalline choline chloride, 20: 378
LEONIS, J., Preparation of labeled proteins and peptides, 20: 344 (EUR-1845.f)
LEPEKHIN, F. G., Interaction of 7.2-Bev/c π^- mesons with nuclei, 20: 1224
LEPSCKY, C., Uranium and fission products release from uranium dioxide, 20: 894 (RT/CHI(65)27)
LE QUINIO, R., Atmospheric diffusion experiments on French nuclear sites, 20: 540 (CONF-650407, pp 394-404)
LERMAN, Sidney, Nucleic acid metabolism in the lens. III., 20: 89
LESCRENIER, C., Obtaining isodose curves using film dosimetry, 20: 671
LESHCHENKO, S. S., Characteristics of radiation crosslinkage of polyolefins and their copolymers in N_2O medium, 20: 402
LESLIE, D. C., Calculation of collision probabilities in cluster-type fuel elements, 20: 1138
LESPERANCE, Jacques, Radiopelvimetry by Swedish method, 20: 187
LESSEL, A., Pulmonary ventilation after intense irradiation of bronchial carcinomas, 20: 159
LE TOURNEUX, Jean, Penetration effects in internal conversion of ^{203}Tl, 20: 1181
LETTRE, H., Production of 6-azacholesterin labeled with ^{14}C in C-4 or C-26 position, 20: 345 (EUR-2450.d)
LEVAI, Andras, Present state and prospects of utilizing nuclear power, 20: 1481
LEVEQUE, P., Nuclear graphite, 20: 756
LEVIN, Ernest M., System WO_3–B_2O_3, 20: 847
LEVIN, Iddo, Method and device electrolytic dissolution depleted uranium fuel elements, 20: 454
LEVIN, V. L., Protecting cells from damaging effects of uv irradiation, 20: 139
LEVINE, Melvin M., Safety considerations based on design experiences in BNL settled-bed fast reactor concept, 20: 1456 (BNL-9475)
LEVY, R. H., Effect of coherent radiation on stability of crossed-field electron beam, 20: 499 (NP-15541)
LEVY, Roy, Nuclear weapons effects on shipboard electronic systems. II., 20: 617 (AD-611540)
LEW, H., Rotational spectra of TlF by molecular beam electric resonance method, 20: 1327
LEWIS, H. R. Jr., Approach to screening for Coulomb wave functions, 20: 967
LEWIS, Lionel, The development and use of meteorological map overlays for emergency purposes at a power reactor facility, 20: 561 (CONF-650407, pp 439-54)
LEWIS, Miles B., Prog. rpt. on [seismic wave detection], 7/30/65, 20: 543 (NVO-98-9)
LEYDEN, Donald E., Analysis of deuterium oxide–water mixtures, 20: 239
LI, N. C., Metal complexes in solvent extraction studies. III., 20: 261
LIAS, Sharon G., Gas-phase radiolysis and photolysis of neopentane, 20: 369
LIBOTTE, P., Nondestructive testing of fuel rods, 20: 794
LIEBERMAN, M. L., Thermodynamics of scandium–hydrogen system, 20: 322
LIEBERMAN, Rose, Genetic factors influencing irradiation protection by bone marrow. V., 20: 138
LIERMANN, Jean, System for providing an electrical connection along a nuclear reaction channel, 20: 1368
LIESER, K. H., Homogeneous redox reactions in sulfate-ion-containing solutions. III., 20: 296
LIIKALA, R. C., PuO_2–UO_2 experimeat in the EBWR, 20: 1457 (BNWL-126)
LIKHTENSHTEYN, E. A., Use of cybernetics in development of radiation therapy, 20: 167 (N64-20943, pp 35-46)
LIND, N. C., Rapid method to estimate the elastic stress concentration of a nozzle in spherical pressure vessel, 20: 1364
LINDACKERS, K. H., Theoretical and experimental results useful for estimation of inhalation radiation dose and environmental radioactive contamination, 20: 560 (CONF-650407, pp 362-80)
LINDBERG, Robert G., Mechanisms of radiation resistance in pocket mice, 20: 114
LINDENBRATEN, L. D., Use of cybernetics in development of radiation therapy, 20: 167 (N64-20943, pp 35-46)
LINDER, F., Inelastic scattering of low-energy electrons on methane, propane, and n-heptane, 20: 335
LINDER, Per J., Fission product release under accident conditions and radiological consequences, 20: 569 (CONF-650407, pp 603-8)
LINDHOUT, A. H., Neutrino physics, 20: 999
LIPOVSKA, M., Measurement of soft β-radiation in biological material with aid of liquid scintillators. II., 20: 253
LISCO, Hermann, Tumor induction in mice by radioactive thymidine, 20: 66 (TID-22292)
LITERAT, R., Gamma-gamma angular correlation measurements of thermal-neutron-capture γ rays in ^{200}Hg, 20: 1152 (IFA-RN-21)
LIU, L. S., Weak N* production and SU(6), 20: 1020
LLOYD, J. L., Double resonance production by 2.77-Bev/c π^+ mesons on hydrogen, 20: 1019
LLOYD, Jennifer, Triprolidine and response of skin to uv radiation, 20: 132
LO, G. Y-S., Infrared band width of the nitrate ion ν_3 mode, 20: 324
LOCKETT, George Edward, Fuel elements for nuclear reactors, 20: 1451
LOFFTUS, F. H., Method of making nuclear fuel compact, 20: 808
LOFFTUS, Fred H., Method of making nuclear fuel compact, 20: 804
LOFLAND, Hugh B. Jr., Ionizing radiation, atherosclerosis, and lipid metabolism in pigeons, 20: 110
LONG, E. L. Jr., Examination of Bonus preheater-dryer piping, 20: 1471 (ORNL-TM-1282)
LONGWORTH, G., Moessbauer effect in tin-rich alloys, 20: 862
LONTZ, Robert J., Electron spin resonance of γ-irradiated fluoroalcohols, 20: 372
LOONEY, William B., Effects of radiation on mammalian cells, 20: 121
LORANG, Bernard, Improvement of the melting-without-crucible technique, for refractory oxides, 20: 798
LORANT, Michael, Is polonium (^{210}Po) the cancer-inducing factor in excessive cigarette consumption? 20: 158
LORENZELLI, N., Resistivity and magnetic susceptibility of cerium nitride at low temperature, 20: 1332
LOSERIES, Hans-Georg, Circuit arrangement for portable radiation detection instruments, especially dose-rate meters, 20: 683
LOVE, C. M., Effect of tartaric acid on kinetics of oxidation of uranium(IV) by thallium(III) in aqueous perchloric acid, 20: 319
LOVE, W. J., Influence of small weld cracks on fatigue life of steel pipe for nuclear service, 20: 759

LOVERA, G., Use of plastobalt in dermatological therapy. Five years' experience, 20: 177
LOVERDO, A., Application of γ level gages for controlling glass furnaces, 20: 714
LUDLUM, Donald G., Alpha-particle counter and integrating circuit arrangement, 20: 686
LUKYANOV, A. A., Generalized Porter-Thomas distribution, 20: 1188
LUK'YANOV, V. K., Elastic scattering of fast electrons on nuclei with Fermi distribution of charge density, 20: 1156 (JINR-P-2370)
LUK'YANTSEV, A. F., Method of finding conventional extrema, 20: 734 (JINR-P-1988)
LUSE, Robert A., Resonance in radiation effects, 20: 46 (PRNC-40)
LYMPERES, C. J., The compatibility of compacted boron carbide in stainless steel–alkali metal systems, 20: 776 (TIM-822)
LYNDEN-BELL, D., Gravitational stability of uniformly rotating disks, 20: 952
LYNDEN-BELL, D., Spiral arms as sheared gravitational instabilities, 20: 953
LYONS, M. F., Irradiation of 0.5-inch diameter, solid-pellet UO_2 fuel rods at 700,000 Btu/hr-ft^2 peak heat flux, 20: 893 (GEAP-5100A)
LYONS, M. F., Release of fission products from UO_2 operating at high power rating, 20: 579 (CONF-650407, pp 885-907)
LYTLE, James Bert, Study of AET on mitotic growth in bone marrow of rat, 20: 143

M

MAC DONALD, J. C. F., Obtaining multifield and rotational dose distributions in ^{60}Co teletherapy, 20: 208
MAC DONALD, Norman S., Short-term retention of ^{85}Sr and estimation of initial ^{90}Sr burdens in humans, 20: 32
MACHARADZE, T. S., Velocity-dependent potential and deuteron photodisintegration at high energies, 20: 1195
MACKU, J., Results of systematic six years' measurement of atmospheric fallout, 20: 537
MAC PHERSON, R. E., Prog. rpt. on SNAP-8 corrosion program, 5/65, 20: 773 (ORNL-3859)
MAGEE, R. M., Steady-state radiation effects on electronic components and circuits, 20: 695
MAHAUX, C., Analysis of ^{6}Li(n,^{3}H)^{4}He integrated and differential cross sections, 20: 1180
MAILLET, Emmanuel, Fuel element for nuclear reactor, 20: 1443
MAILLIE, H. D., Dose and energy among major organs of a beagle cadaver, 20: 604
MAILLIE, H. David, Effect of thickness on central beam dose received by beagle exposed to 1000-kvp x rays, 20: 113
MAITY, H. P., Microestimation of zirconium with ^{32}P by radiometric procedure, 20: 258
MAJOR, R. W., Electrical resistance of cerium as determined by temperature and crystal structure, 20: 829 (TID-22275)
MAKAROVA, R. V., Distribution of elements during formation of sintered alloys in W–Ni–Fe system, 20: 865
MAKHUNKA, I., Investigation of the α spectrum of ^{149}Gd, 20: 1220
MAKHUNKA, M., Investigation of the α spectrum of ^{149}Gd, 20: 1220
MALAKHOF, V., Criticality of fuel reprocessing equipment, 20: 591 (GAMD-6623)
MALINOVSKII, O. V., Post-radiational regeneration of yeast cells during stationary phase of growth, 20: 79
MAMASAKHLISOV, V. I., Velocity-dependent potential and deuteron photodisintegration at high energies, 20: 1195
MAMMI, M., Relative orientation of the twinned polythiomethylene crystals from trithiane by γ irradiation, 20: 353
MAMURO, Tetsuo, Studies on fallout particles. IV., 20: 535
MANCUSO, R. V., Energy levels of ^{143}Pr, 20: 1199
MANES, Roger, Solid construction of moderator for nuclear reactors, 20: 1390
MANN, D. B., Analysis of pulsed refrigeration system, 20: 1263 (NBS-8817)
MANN, D. B., Cryogenic aspects of Project Sherwood magnet refrigeration, 20: 1265 (NBS-8846)
MANNING, P. G., Chloride and sulfate ion association with lanthanide and actinide ions, 20: 299
MANSKER, Joseph S., Inflorray manscreen, 20: 188
MANTOVANI, G. C., Photoproduction of π^+ in ^{4}He and possible existence of an unstable ^{4}H state, 20: 1210
MANZINI, R., Buildup factors for concrete: coefficients of the polynomial representation, 20: 1311 (RT/FIMA(65)2)
MARAIS, P. G., Cobalt-60 irradiation unit for agricultural research, 20: 697
MARAMAN, W. J., Equilibrium temperature for the plutonium α-β transformation, 20: 822 (LA-DC-7278)
MARCHANDISE, H., Plasma gun and its applications, 20: 1277 (TID-22136)
MARCHANT, H., Magnetic analysis of the ^{51}V(d,p)^{52}V reaction, 20: 1167
MARGEN, Peter H. E., Nuclear reactor, 20: 1432
MARINOV, M. S., Experimental data on resonance widths and SU(3)-symmetry predictions, 20: 1025
MARION, J. B., M1 character of the 17.64 to 16.62 transition in ^{8}Be, 20: 1197
MARKAKIS, P., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 702 (COO-1283-27)
MARKHAM, Jordan J., Electron-nuclear wave functions in multiphonon processes. II., 20: 1342
MARKOV, B. N., Synthesis of fissionable isomer in ^{241}Am(n,γ)^{242}Am reaction, 20: 1155 (JINR-P-2347)
MARSHALL, W., Moessbauer effect of ^{57}Fe in cobalt single crystal, 20: 1198
MARSICO, B., Average cosine of scattering angle for particles in a Maxwellian gas, 20: 1135 (RT/FI(65)12)
MARTIN, Jean Antoine, Shock-absorbing device for nuclear reactor control rods, 20: 1393
MARTIN, Robert L., Radiation stability of uranium mononitride, 20: 888 (BMI-1731)
MARTIN, Roger, Handling apparatus for gas-cooled nuclear reactor installation, 20: 1399
MARTIN, W. R., Irradiation embrittlement of low-boron type 304 stainless steel, 20: 898
MARTINI, S., Oscillographic polarography of oxygen ions in molten nitrates, 20: 285 (EUR-2496.e)
MARTYNENKO, L. I., New compounds of rare earths with strontium and barium oxides, 20: 302
MARTYNENKO, L. I., New compounds of rare earths with lithium, 20: 303
MASON, A., Neutronic reactor with interlocking diffuser end grid, 20: 1524
MASON, Edward A., Prog. rpt. on thermal diffusion in gases, final, 9/56–8/65, 20: 963 (TID-22313)
MASON, Robert M., Filter pack technique for classifying radioactive aerosols by particle size. IV., 20: 599 (NRL-6306)
MASSIGNON, Daniel, Determination of characteristics of porous barriers and instrument for practical application of said method, 20: 728
MASSOTH, F. E., Degradation of C-816 and C-437 with fluorine, 20: 346 (GAT-L-420)
MASTEL, B., Combined effect of carbon and neutron radiation on molybdenum, 20: 895
MATHE, G., Prog. rpt. on immunologically competent cells, annual, 1964, 20: 55 (EUR-2469.f)
MATHENEY, G. B., Engineering test program to investigate consequences of loss-of-coolant accident, 20: 567 (CONF-650407, pp 567-77)
MATHESON, C. C., Variable helium film transfer rates down to 0.5°K, 20: 1125
MATINYAN, S. G., Broken Schwinger symmetry W_3, 20: 1075
MATLOCK, O. D., New, versatile vacuum quick-seal and vacuum lock, 20: 505 (ORNL-P-1517)
MATOUSEK, J., Investigation of radioactivity in Pizen, 20: 522
MATSUNAMI, Tadao, Studies on fallout particles. IV., 20: 535
MATSUSHITA, S., Ionospheric perturbation (roles played by ionosphere in geomagnetic pulsations), 20: 1101
MATSUURA, Hajime, Effect of mitomycin-C on the frequency of chromosome aberrations produced by x rays, 20: 71
MATSUYAMA, Akira, Evidence for formation of chlorine atoms in neutral aqueous solution containing chloride ions by ionizing radiations, 20: 360
MATTELAER, G., Advantages of treating skin neoplasia with soft x rays, 20: 171
MATUTANO, Luis, Extraction of some acids using aliphatic amines, 20: 223 (CEA-R-2760)
MATVEEVA, A. V., Radiation polymerization of diketene in solid and liquid states, 20: 398
MAULARD, Jean, Nuclear reactor control rod operating device, 20: 1369
MAUSTELLER, J. W., Development of medium flowrate, high-purity particulate and iodine filters, 20: 589 (CONF-650407, pp 1204-15)
MAUTZ, E. W., Use of cut-crown magnesium in production of uranium metal, 20: 749 (NLCO-965, pp 1.1-5)
MAWBEY, M. W. S., Scale-model investigation of flow from open end of shock tube of rectangular cross section, 20: 912 (AWRE-O-61/65)
MAXFIELD, Bruce Wright, Superconducting penetration depth in niobium, 20: 1131
MAY, A. D., Vibrational frequency perturbations in Raman spectrum of hydrogen, 20: 300
MAYKUTH, D. J., Metallurgical evaluation of new tungsten product, 20: 879
MAZZOCCO, N. J., Prog. rpt. on evaluation of β irradiation of pressurized reactions, 11/63–10/64, 20: 355 (NYO-2978-42)
MAZZOLENI, G. P., Aluminum and aluminum–uranium alloy plates dissolution in acid and acid-deficient conditions. I., 20: 438 (RT/CHI(65)23)
MAZZUOLI, G. F., Effects of osmotic diuresis on renal clearance of ^{85}Sr and ^{45}Ca in the dog, 20: 30
MC CARTNEY, R. N., Radioisotopes today, 20: 207
MC CLOSKEY, M. W. Jr., New technique for remote weighing, 20: 476 (LA-DC-7150)

MC CLURE, G. W., Differential angular distribution of H and H^+ dissociation fragments of fast H_2^+ ions incident on H_2 gas, 20: 977
MC CLURE, J. A., Analysis of excursion behavior of highly enriched plate-type D_2O-moderated core in SPERT II, 20: 1412 (IDO-17109)
MC CULLEN, J. D., Spin, hyperfine structure, and new magnetic moment of 21-min ^{52m}Mn, 20: 1204
MC CULLOUGH, C. Rogers, Accident models and hazard evaluation, 20: 586 (CONF-650407, pp 1071-9)
MC CURDY, Paul R., Detection of intestinal absorption of ^{57}Co tagged vitamin B_{12} by serum counting, 20: 28
MC DONALD, Jose, Metallurgical evaluation of the LACBWR forced-circulation clad piping, 20: 788 (SWRI-1228-73)
MC DONALD, R. E., Irradiation embrittlement of low-boron type 304 stainless steel, 20: 898
MC DOWELL, A. A., Sex as factor in position-postremity responses of Rhesus monkeys, 20: 92
MC EVOY, J. P., Microwave observation of proximity effects in magnetic fields, 20: 1124
MC GONNAGLE, W. J., Quality control and nondestructive testing in reactor pressure vessel fabrication, 20: 1366
MC GRATH, Robert G., Fluid flow radioactivity measuring apparatus and sampling means, 20: 690
MC GUIRE, E. J., Model for atomic excited states eigenvalues and eigenfunctions, 20: 960
MC GUIRE, R. L., Rejection of NaI pulse pile-up in linac bremsstrahlung measurements, 20: 651 (EGG-1183-2055)
MC INERNEY, Joseph John, Normal mode solution of neutron slowing-down problem, 20: 1141
MC INTYRE, J. A., Nuclear spectroscopy with energy resolution of a part per million, 20: 1252
MC KAY, H. A. C., Uranium(IV) nitrate and perchlorate species in tri-n-butyl phosphate solutions, 20: 321
MC KENZIE, D. R., Influence of iron on oxygen grain-boundary diffusion in periclase crystals, 20: 830 (UCRL-14215)
MC KEOWN, M., Proton-neutron coupling in odd-odd Re and Ir nuclei, 20: 1145 (BNL-8168)
MC LEAN, F. B., Nucleation of superconductivity in wedge geometry, 20: 1123
MC MANUS, H., Excitation of quadrupole and octupole levels of ^{12}C, ^{16}O, ^{40}Ca by 156-Mev protons, 20: 1215
MC NALLY, J. R. Jr., Fusion chain reactions, 20: 1275 (ORNL-3836, pp 117-19)
MC NICHOLAS, J. J., High-temperature corrosion testing between silica and lead, lead bromide, and bromine, 20: 1559 (BNL-9473)
MEAD, K. F., Shock tube 30 × 18 in., 20: 619 (AWRE-O-59/65)
MEDVEDEV, S. S., Gamma-induced polymerization of isobutylene in presence of solids, 20: 403
MEHENDRU, P. C., Evidence of different types of F centers from thermoluminescence studies in x-irradiated alkali halides. I., 20: 903
MEHROTRA, R. C., Organic compounds of lanthanide elements, IV., 20: 316
MEILING, W., Measurement of nanosecond lifetimes in deformed nuclear levels, 20: 1175
MEISSNER, Hans-Georg, Constitution of some systems homologous and quasi-homologous to ^3T–Ga. I., 20: 871
MEISTER, G., Inelastic scattering of low-energy electrons on methane, propane, and n-heptane, 20: 335
MELENDRES, Carlos A., Solubilities, conductances, viscosities and densities of solutions of selected inorganic compounds in dimethyl sulfoxide, 20: 293 (UCRL-16330)
MELMED, Allen J., Adsorption and surface diffusion of copper on tungsten, 20: 849
MELVER, E. J., Equilibrium oxygen pressure over stainless steels and relation to reactor fuel stability, 20: 277 (AERE-R-4942)
MELVILLE, G. S. Jr., Radioprotection with AET–cysteine in Rhesus monkey, 20: 140
MELYUKHIN, S. T., Properties of space and time in the microworld, 20: 1042
MENDEZ PENALOSA, R., Nuclear pilot graphite plant of JEN, 20: 790
MEREDINO, S., Effects of osmotic diuresis on renal clearance of ^{85}Sr and ^{45}Ca in the dog, 20: 30
MERLI, Elio, Device for prevention of excessive pressure originating in primary circuit of nuclear power plant, 20: 1520
MERMAGEN, H., Dose and energy among major organs of a beagle cadaver, 20: 604
MERMAGEN, Herbert, Effect of thickness on central beam dose received by beagle exposed to 1000-kvp x rays, 20: 113
MERTI, F., Investigation of radioactivity in Plzen, 20: 522
MERTL, F., Survey of work with radioisotopes, 20: 12
MESHII, M., Point defect hardening of aluminum. I., 20: 896
MESTRE, Emile, Ultrasonic copper and brass decontamination study, 20: 430 (CEA-R-2823)
MEYER, Eugene Frank Jr., Fission of ^{238}U induced by low-energy protons, 20: 1247
MEYER, Klaus, Reactor with thickened fuel suspension circulated through tubes, 20: 1447
MICHEL, Bourgeois, Separation of uranium and plutonium, 20: 445
MIDANA, A., Use of plastobalt in dermatological therapy. Five years' experience, 20: 177
MIHAIL, Arlette Marcelle, Process and devices of heat exchange and nuclear reactor embodying same, 20: 1400
MIKHAILOV, V., Investigations of chronic γ irradiation of heart, liver, and kidneys, 20: 102
MIKULSKI, Jan, Radiochemical separation of some metal ions by extraction chromatography, 20: 433 (INP-412/C)
MILBURN, Richard H., Laser beams. Production of polarized and monochromatic γ radiation, 20: 936 (SLAC-41)
MILFORD, R. P., Fused-salt fluoride-volatility process for recovering uranium from spent aluminum-based fuel elements, 20: 442
MILLER, Albert Eugene, Nonstoichiometric rare-earth oxides, 20: 880
MILLER, C. E. Jr., In-pile fission product release experiments: atmospheric effects, 20: 559 (CONF-650407, pp 276-91)
MILLER, J. M., Nuclear-structure effects in high-energy (p,n) reactions, 20: 1213
MILLER, R. H., Resolution of multi-event ambiguities in wire spark chambers by means of extra wire, 20: 650
MILLER, R. R., High-temperature properties of potassium, 20: 286 (NRL-6233)
MILLER, Richard H., Prog. rpt. on computer research, 8/65, 20: 732 (COO-614-37)
MILLHOUSE, A. H., Temperature dependence of the optical reflectivity of cerium metal, 20: 917 (TID-22277)
MILLS, R. L., Crystal structure of normal hydrogen at low temperatures, 20: 1340
MILNER, G. W. C., Determination of plutonium by potentiometric titration, 20: 222 (AERE-R-4975)
MINC, Stefan, EPR spectra of γ-irradiated single crystals of β-succinic acid, 20: 389
MINCZEWSKI, Jerzy, The kinetics of U(V) ions disproportionation in organic acid solutions, 20: 328
MINER, W. N., Effects of dilute rare-earth additions on electrical conductivity of cerium at low temperatures, 20: 864
MINGRONE, P., Determination of air stability according to Pasquill's criteria for Italian stations, 20: 515 (RT/PROT(65)17)
MIRONOVA, T. M., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
MISHAKOVA, A. P., Angular distribution of secondary particles in high-energy nuclear interaction, 20: 984 (IAE-574)
MISKEL, John A., Radioactivity: distribution from cratering in basalt, 20: 613
MISRA, S. N., Organic compounds of lanthanide elements. IV., 20: 316
MISRA, T. N., Organic compounds of lanthanide elements. IV., 20: 316
MITCHELL, T. E., Three-stage hardening in tantalum single crystals, 20: 837
MITROFANOVA, L. V., Characteristics of radiation crosslinkage of polyolefins and their copolymers in N_2O medium, 20: 402
MITTAL, M. L., Amperometric determination of UO_2^{++} as vanadate, 20: 255
MITTLEMAN, M. H., Theory of low-energy-electron scattering by polar molecules, 20: 973
MITYUSHOVA, N. M., Post-radiational regeneration of yeast cells during stationary phase of growth, 20: 79
MIYAGAWA, Ichiro, Proton-deuteron exchange of the radical in irradiated single crystals of DL-aspartic acid, 20: 373
MIYAKE, Hideo, Radiation-induced polymerization of cyclic dienes, 20: 383
MIYAKE, Mikio, Constant temperature wind component meter development and application, 20: 516 (TID-22278)
MOENIG, H., ESR investigations of uv- and x-irradiated homocysteine-thiolactone, 20: 386
MOHAMED, S. D., Effect of treatment of thyrotoxicosis on exophthalmos, 20: 176
MOHRHAUER, H., Industrial utilization of radioisotopes, 20: 706
MOLE, R. H., Mucus-depleting action of bile in small intestine of irradiated rats, 20: 78
MOLEN, G. F., Recovery of plutonium from miscellaneous analytical laboratory wastes, 20: 435 (RFP-551)
MOLIN, N., Toxin production by Clostridium botulinum in vacuum-packed, irradiated fresh fish, 20: 707
MOLINA, J., Incorporation of nuclear energy into the Spanish electrical system, 20: 1576
MOLINARI, V. G., Average cosine of scattering angle for particles in a Maxwellian gas, 20: 1135 (RT/FI(65)12)
MONACO, Anthony P., Biology of tissue transplantation. II., 20: 104
MONK, M., Indirect uv induction of prophage λ and colicin I factor, 20: 127
MONTALVO, Rafael, Radiolysis of estrone and estradiol, 20: 396

MONTEIL, Marcel, Loading machine for nuclear reactors channels, 20: 1391
MONTEITH, L. K., Electron irradiation effects on capacitor-type micrometeoroid detectors, 20: 692
MOONEY, L. G., Calculating penetration of neutron and γ radiation into underground concrete structures, 20: 1307 (RRA-M45)
MOORE, David, Liquid-protected electrodes, 20: 502
MOORE, S. E., CERL-II. Computer program for analyzing hemisphere-nozzle shells, 20: 459 (ORNL-3817)
MORAN, George, Gallium concentrations in metal phases of various meteorites, 20: 530
MORCZEK, A., Effectiveness of particular hematological criteria for judging radiation exposure, 20: 116
MORCZEK, A., Radiation damage to hematopoietic system. I and II., 20: 64 (SZS-5(1965))
MORETTA, L., Changes in blood lipids in irradiated rats with reference to age and dose, 20: 77
MORGAN, G. H., Cosmotron magnetic field measurements, 20: 932 (BNL-9557)
MORGAN, J. G., Fission-gas release from pyrolytic-carbon-coated fuel particles during irradiation at 2000 to 2500°F, 20: 899
MORGAN, O. B., High-current ion-beam production and injection, 20: 962 (ORNL-3836, pp 74-80)
MORINAGA, H., Isospin selection rules in photoeffects on heavy nuclei, 20: 1226
MORISHIMA, Hiroshige, Behavior and distribution of radionuclides in suspended matter in seawater. I., 20: 612
MORIZANE, K., Impurity distribution in single crystals. I., 20: 1573 (TID-22314)
MORLOTTI, R., Electrode overvoltages in molten fluorides. III., 20: 284 (EUR-804.e)
MORPURGO, G., Test of nonrelativistic quark model for elementary particles, 20: 1016
MORRIS, J. B., Deposition of iodine vapor on surfaces, 20: 215 (CONF-650407, pp 142-77)
MORRIS, J. M., Measurements of energy distribution of charged particles after passage through a thin foil, 20: 969
MORRISON, B. H., High-temperature thermal diffusivity measurements by flash technique, 20: 823 (LA-DC-7456)
MORRISON, D. L., Critical analysis of the blowdown accident, 20: 570 (CONF-650407, pp 609-40)
MORRISON, D. L., Fission product release from coated particle fuels under accident conditions, 20: 556 (CONF-650407, pp 56-72)
MORRISON, D. L., Fission-product deposition in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
MORRISON, H. G., Variation of x-ray sensitivity of Serratia marcescens with relative humidity, 20: 99
MOSTOFI, F. K., Acute radiation nephritis, 20: 190
MOURET, Pierre, Method for leaching uranium-containing ores, 20: 451
MOURIER, Georges, Cyclotron, 20: 945
MUAN, A., Activity-composition relations in some oxide and alloy phases at elevated temperatures, 20: 338
MUHLENHAUPT, R. C., Analysis of pulsed refrigeration system, 20: 1263 (NBS-8817)
MUHLENHAUPT, R. C., Cryogenic aspects of Project Sherwood magnet refrigeration, 20: 1265 (NBS-8846)
MUKERJEE, D., Chromatographic separation of rare earths and uranium from thorium, 20: 449
MUKOYAMA, Takeshi, Incoherent scattering of γ rays by K-shell electrons, 20: 978
MULLER, J., Density of states of chromium and its alloys, 20: 1330
MULLER, Rolf H., Optical techniques for study of phase boundaries, 20: 290 (UCRL-11997)
MULLINS, L. J., Fused-salt electrorefining of molten plutonium, 20: 443
MULVIHILL, Robert J., Probabilistic methodology for safety analysis of power reactors, 20: 1461 (CONF-650407, pp 1035-56)
MUNCE, J. F., The architect in the nuclear age, 20: 1577
MUNGYEROVA, G., Effect of ionizing radiation on biological activity of gliomas, 20: 101
MUNN, Peter Neil, Organic liquid moderated and cooled nuclear reactors, 20: 1429
MUNTENBRUCH, Helmut, Production of short single pulses in high-current discharges, 20: 1095
MURAKAMI, Akio, RBE of 14. 1-Mev neutrons in killing dormant silkworm eggs, 20: 72
MURAMATSU, Hiroshige, Radiation-induced addition reaction of ethers to fluorine-containing olefins, 20: 395
MURAMATSU, Mitsuo, Skin contamination by radioactive isotopes. III., 20: 40
MURAV'EVA, I. A., New compounds of rare earths with lithium, 20: 303
MURTHY, V. Rama, Rb–Sr ages of chondrules and carbonaceous chondrites, 20: 529
MUSAEV, U. N., Densities of radiation graft copolymers, 20: 401
MUSSO, G., Vanadium as diffusion barrier between aluminum and uranium, 20: 855
MUZINICH, I. J., Sum rules for meson-meson interactions, 20: 1004
MYERS, J. L., Testing of ten-ton UF_6 cylinders, 20: 593 (KY-500)
MYERS, T. R., Parametric evaluation of DTPA, EDTA, and HEDTA for ion exchange purification of promethium, 20: 429 (BNWL-69)

N

NACHTIGALL, Dieter, Apparatus for determination of effective energy of fast neutrons, 20: 681
NACHTIGALL, K. H., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
NAGAI, Mamoru, Quantitative analysis of yttrium in steel by solution spectrographic analysis, 20: 266
NAGATA, Takesi, Geomagnetic pulsation pc-5 in and near auroral zones, 20: 1105
NAGEL, R., Clinical problems of kidney transplantation in humans, 20: 125
NAHA, P. M., Development of improved strains of Streptomyces citreus through induced mutation, 20: 124
NAKAMURA, Yasuji, Nuclear fuel problems in Japan, 20: 1439
NAKAYAMA, Tadayuki, Structure of oxide films formed on Zr surface, 20: 778
NAKAYAMA, Yasuyuki, Incoherent scattering of γ rays by K-shell electrons, 20: 978
NAMIKI, Mitsuo, Evidence for formation of chlorine atoms in neutral aqueous solution containing chloride ions by ionizing radiations, 20: 360
NANDI, P., Development of improved strains of Streptomyces citreus through induced mutation, 20: 124
NASSEF, M. H., Reaction (d,p) of ^{23}Na in energy range from 1.0 to 2.5 Mev, 20: 1185
NAUMANN, R. A., Decay of ^{101m}Rh and ^{101g}Rh, 20: 1205
NAVEZ, Emile, Apparatus for heating metals to high temperatures, 20: 479
NAYLOR, G. P., Thermoluminescent phosphors: variation of quality response with dose, 20: 669
NEILL, F. H., Model for fission product transport and deposition under isothermal conditions, 20: 1349 (ORNL-TM-1274)
NELSON, Lawrence V., Development and calibration of the PR-3 flowmeter, 20: 620 (COO-401-118)
NELSON, R. C., Irradiation of 0.5-inch diameter, solid-pellet UO_2 fuel rods at 700,000 Btu/hr-ft^2 peak heat flux, 20: 893 (GEAP-5100A)
NEMETH, Stephen R., Thorium–1.4% ^{235}U metal fuel tubes—fabrication and irradiation in HWCTR, 20: 782 (DP-943)
NENTWIG, G., Some notes on scintillation counting devices for β dosimetry using thin plastic scintillators, 20: 663
NETTELAND, Olav, Photographic isodose measurements in inhomogeneous matter, 20: 162 (CONF-640918-2)
NEUWIRTH, Jerome H., Linear and antilinear transformations, 20: 737
NEWBY, B. J., Fission product sorption by protective coatings, 20: 573 (CONF-650407, pp 720-9)
NEWMAN, P., Interpretation of early magnetic transients caused by high-altitude nuclear detonations, 20: 1102
NEWTON, K. A., Clinical application of bone marrow grafts, 20: 134
NEZRICK, F. A., Measurement of reaction $\nu_e + p \rightarrow \beta + n$, 20: 992 (COO-818-65)
NGUYEN-TRUNG, C., Absorption of stopped π^- mesons by ^{12}C nuclei, 20: 1193
NGUYEN VAN HIEU, Structure of vertex parts in symmetries SL(6) and U(12), 20: 1055 (JINR-P-2338)
NICHOLAS, R. C., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
NICHOLLS, B., Deposition of iodine vapor on surfaces, 20: 215 (CONF-650407, pp 142-77)
NICOSIA, S., Reactor for organic moderated critical experiments, 20: 1413 (RT/ING(65)4)
NIEZABITOWSKI, Aleksander, Chemical protection from ionizing radiation. IV., 20: 131
NIKIFOROV, M. V., Determination of water supplies in snow deposits by aerial γ exposure, 20: 549
NIKOL'SKII, V. G., Study of polymer mixture by radiothermoluminescence, 20: 366
NILSSON, J., Measured and predicted thermal- and fast-neutron fluxes in air-filled annular ducts, 20: 1317
NILSSON, Jan, Method for prediction of neutron attenuation in annular ducts, 20: 1139
NIMNI, M. E., Localized γ irradiation from ^{60}Co on synthesis of collagen by subcutaneous granulomas, 20: 52
NISHIDA, Atsuhiro, Storm sudden commencements as solar blast waves, 20: 1107
NISHIKAWA, T., Dispersion relation and frequency characteristics of alternating periodic structure for linear accelerators, 20: 931 (BNL-9554)

NISHIKAWA, T., Normal mode analysis of standing wave linacs, 20: 929 (BNL-9514)
NISHIWAKI, Yasushi, Behavior and distribution of radionuclides in suspended matter in seawater. I., 20: 612
NITSCHKE, Eberhard, Method for reduction of deuterium losses in isotopic exchange with a liquid cycle, 20: 729
NIZZA, P., Distribution of ^{144}Ce in bone tissue of the rat, 20: 34
NOFAL, Mohamed M., Treatment of malignant disease of thyroid, 20: 196
NORBERG, J. A., Analysis of excursion behavior of highly enriched plate-type D_2O-moderated core in SPERT II, 20: 1412 (IDO-17109)
NORWOOD, J. M., Formulation of radiation transport solutions for shielding applications, 20: 1303 (AD-614250)
NOVATSKII, B. G., Investigation of the $^3He + ^3He$ reaction, 20: 1154 (JINR-P-2323)
NOVIK, I. B., Visualizability and models in theory of elementary particles, 20: 1050
NOVIKOV, Yu. V., Radium content of a human body, 20: 603
NOYES, H. E., ICC regulations and permits for safe transportation of explosives, 20: 594 (LA-DC-7469)
NUERINGER, L. J., Effects of high magnetic fields on ultrasonic velocity and attenuation in Nb–25% Zr, 20: 863
NUGENT, R. C., Preshot investigations for project Pre-Schooner, Buckboard Mesa, Nevada Test Site, 20: 511 (PNE-505P)
NUSSINOV, S., Sum rules for meson-meson interactions, 20: 1004

O

OBLINGER, C. J., Uranium–carbon phase diagram: melting points of uranium with various carbon levels, 20: 825 (NLCO-965, pp 2 1-3)
OCSAI, Mihely, The role of nuclear power plants in cooperative power plant systems, 20: 1488
ODDIE, T. H., Comparison of thyroidal iodide accumulation and thyroxine secretion in euthyroid subjects, 20: 36
OELGAARD, P. L., Neutronic method for measuring water content in soil, 20: 632
OETTING, F. L., Determination of plutonium in plutonium oxide by calorimetry, 20: 259
OGDEN, H. R., Metallurgical evaluation of new tungsten product, 20: 879
OGURA, Ryohei M., Biochemical changes in rat epidermis induced by chronic uv exposure, 20: 93
OGURTZOV, V. I., Photoneutron cross section of ^{12}C, 20: 1196
OHNISHI, Takeaki, Distribution of stray radiation in radiographic examination, 20: 606
OKAMURA, Seizo, Radiation-induced polymerization of cyclic dienes, 20: 383
OKU, T., Detection of embrittlement in steels by means of hardness measurements, 20: 860
OKUBO, Tsutomu, Fused zirconia refractories. III., 20: 867
OLANDER, Donald R., High-temperature chemical engineering research in nuclear technology, 20: 292 (UCRL-16173)
OLDAKER, I. E., Sheath temperatures. G-20 computer program for fuel bundles, 20: 480 (AECL-2269)
OLIVARI, A., Use of ^{99m}Tc in hepatic scintillography, 20: 197
OLIVER, R., Theoretical growth-rate curves for Vicia faba roots under continuous radiation exposure at low dose rate, 20: 87
OLKHOVSKII, V. S., Inelastic scattering of fast neutrons by nuclei of collective type, 20: 1219
OMEL'YANOVSKII, M. E., Philosophical problems of elementary particle physics, 20: 1032
OMEL'YANOVSKII, M. E., Problem of elementarity of particles in quantum physics, 20: 1038
OMEL'YANOVSKII, M. E., Quantum physics and transmutability of elementary particles, 20: 1045
ONDRACEK, Gerhard, Preparation and hot pressing of UN, 20: 799
ONDRACEK, Gerhard, Properties of intermetallic compounds of uranium, 20: 873
O'NEAL, Danny, Gamma attenuation by loblolly pine wood, 20: 1313
ONO, Kenji, Point defect hardening of aluminum. I., 20: 896
ONO, Ryoichi, Behavior and distribution of radionuclides in suspended matter in seawater. I., 20: 612
OPHEL, T. R., Measurements of energy distribution of charged particles after passage through a thin foil, 20: 969
ORCOYEN, S. Garcia, Radiological protection at the JEN-1 reactor, 20: 1538
ORLANDINI, F., The extraction of uranium and plutonium from nitric acid solution by secondary and quaternary ammonium nitrate salts, 20: 437 (RT/CHI(65)21)
ORMEROD, M. G., Free-radical formation in irradiated DNA, 20: 421
ORTIZ DE LA TORRE, J. L., Nuclear pilot graphite plant of JEN, 20: 790
OSBORNE, D. V., Velocity fields of helium II carrying a heat current, 20: 1130
OSETINSKII, G. M., Investigation of the $^3He + ^3He$ reaction, 20: 1154 (JINR-P-2323)
OSTERMIER, B. J., Preliminary design of mercury vapor supersaturation experiment, 20: 481 (NAA-SR-Memo-11194)
OSTLUND, H. Gote, 1964 Hurricane tritium, 20: 519
OTERO DE LA GANDARA, J. L., Nuclear pilot graphite plant of JEN, 20: 790
OTT, Gerhard, Actual Thorotrast problem: a liver sarcoma with intraperitoneal bleeding, 20: 123
OTT, Karl, Fuel element for nuclear reactor, 20: 1448
OVCHINNIKOV, N. F., Conservation principles and problem of structure of matter, 20: 1039
OWEN, C. V., Pneumatic-mechanical high-energy-rate extrusion of yttrium, 20: 783 (IS-1227)

P

PACKWOOD, R. H., Moessbauer effect in tin-rich alloys, 20: 862
PADERNO, Yu. B., Electric properties of Pr_2Se_2 and Nd_2Se_2, 20: 868
PAGET, John Arthur, Apparatus for monitoring structural integrity of control rod for nuclear reactor, 20: 1394
PAKHOMOV, B. Ya., Criterion of relative elementarity, 20: 1041
PALINO, Gerard Francis, Neutron activation analysis of rhenium in rocks, 20: 226 (IS-T-39)
PALLAGI, Dezso, Research reactors, 20: 1537
PALLISTER, E. T., Radiochemical analyses for ^{90}Sr, ^{137}Cs, ^{226}Ra, and ^{40}K in materials, 20: 156
PALMER, H. E., Shadow shield whole-body counter, 20: 659
PANDORF, R. C., Heat capacity and other properties of hexagonal close-packed ^4He, 20: 1336
PAPPAS, A. C., Half-life and decay properties of ^{78}Ge, 20: 1169
PARKER, E., Consumption and production of fissile materials by various types of power reactor, 20: 1463 (EUR-2445.f)
PARKER, G. W., Deposition of fission-product I on structural surfaces, 20: 574 (CONF-650407, pp 730-46)
PARKER, John A., Comparison of uv and γ-induced production of unsaturation and color in polyvinyl chloride, 20: 384
PARSLY, L. F., Deposition of fission-product I on structural surfaces, 20: 574 (CONF-650407, pp 730-46)
PARZEN, G., Choice of profile parameter k_0 and magnet steel for AGS magnets, 20: 930 (BNL-9553)
PASCUAL, F., Incorporation of nuclear energy into the Spanish electrical system, 20: 1576
PASCUAL, R., Muon capture by ^3He and wave function of the trion, 20: 1189
PASHOS, T. J., Irradiation of 0.5-inch diameter, solid-pellet UO_2 fuel rods at 700,000 Btu/hr-ft^2 peak heat flux, 20: 893 (GEAP-5100A)
PASHOS, T. J., Prog. rpt. on stainless steel failure, 2–6/65, 20: 767 (GEAP-4915)
PASTERNAK, A., High-temperature chemical engineering research in nuclear technology, 20: 292 (UCRL-16173)
PASTERNAK, R. A., Interaction of niobium with nitrogen and with oxygen at very low pressures, 20: 775 (SRIA-425-6, pp 10-33)
PASTERNAK, R. A., Prog. rpt. on sorption of gases on metal surfaces in ultrahigh vacuum, 20: 916 (SRIA-425-6)
PATOCKA, S., Investigation of radioactivity in Plzen, 20: 522
PATRIE, Madeleine, Solid solutions formed by addition of sulfides of rare earths to fcc MS sulfides, 20: 332
PATRUTESCU, M., Gamma-gamma angular correlation measurements of thermal-neutron-capture γ rays in ^{200}Hg, 20: 1152 (IFA-RN-21)
PATTENDEN, N. J., Survey of values of the 2200 m/s constants for four fissile nuclides, 20: 1164
PAULI, W., Continuous groups in quantum mechanics, 20: 740
PAULIKAS, George A., Electron capture by high-energy deuterons in gases, 20: 974
PAULING, Linus, Close-packed-spheron model of atomic nuclei and relation to shell model, 20: 1218
PAVLU, V., Effects of radiation on proteins. VI., 20: 67
PAWLOW, Z., Electro- and cardiographic studies of radiation-treated patients with mammary gland cancer, 20: 213
PAYNE, B. R., Isotope survey of the karst region of southern Turkey, 20: 538
PEARLSTEIN, S., Analysis of (n,2n) cross sections for medium and heavy nuclei, 20: 1187
PEARSON, John E., Emanation of radon 222 from soils and its use as tracer, 20: 528
PEDIGO, W. R., Testing of ten-ton UF_6 cylinders, 20: 593 (KY-500)
PEGG, D. E., Freezing of bone marrow for clinical use, 20: 135
PEGORARO, L., Behavior of DNA synthesis in different phases of S-period in chromosomes of human acute leukemia, 20: 20 (EUR-2451.e)
PEHL, Richard H., Reactions (d,α) on ^{12}C, ^{14}N, and ^{16}O induced by 24-Mev deutrons, 20: 1211
PEISL, Hans, Heat conductivity of neutron irradiated LiF, 20: 411
PEKAREK, L., Continuous transition from backward to forward ionization

wave, 20: 1290
PELCE, Jaques, Fuel element for nuclear reactor, 20: 1443
PELLON, Joseph, Radiation-induced block or graft copolymers of methyl methacrylate with isobutylene and ethylene–propylene rubbers, 20: 367
PELSER, A., Distribution of ^{144}Ce in bone tissue of the rat, 20: 34
PENNIGSFELD, F., Permanent automatic control of irrigation from above or below by a neutron probe regime, 20: 633
PENNINGTON, Robert T., Three tank separate superheat reactor, 20: 1523
PERACCHIA, G., Proctosigmoiditis from irradiation, 20: 192
PERELOMOV, A. M., Reduction of direct product of irreducible representations of group SU(3), 20: 1073
PEREZ, R. B., Kinetic theory of spatial and spectral coupling of reactor neutron field, 20: 1411 (CONF-650413-13)
PEREZ-Y-JORBA, J., Current spark chamber used as several-hundred-channel ladder counter, 20: 653 (LAL-1143)
PERLOW, G. J., Moessbauer effect of ^{57}Fe in cobalt single crystal, 20: 1198
PERRY, James William, ESR studies of radiation-damaged single crystals, 20: 414
PETERS, Martin Charles, Improvements in or relating to control of nuclear reactors, 20: 1373
PETERS, Ralph, Absorption of energy by rotating discs in particle beam deflector, 20: 950
PETERSEN, M., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
PETERSON, Donald H., Liquid fluidized bed nuclear reactor and method for reducing particle abrasion therein, 20: 1428
PETKOV, I. Kh., Elastic scattering of fast electrons on nuclei with Fermi distribution of charge density, 20: 1156 (JINR-P-2370)
PETRASCU, M., Gamma-gamma angular correlation measurements of thermal-neutron-capture γ rays in ^{200}Hg, 20: 1152 (IFA-RN-21)
PETRIE, Stuart Lee, Inviscid non-equilibrium flow of an expanded air plasma, 20: 1297
PETROW, Henry G., Analytical development, 20: 417 (NYO-3086-1, Pt.IX)
PETROW, Henry G., Comprehensive survey of ^{226}Ra, ^{228}Ra, ^{228}Th, and ^{210}Pb content of tissues of a radium dial painter, 20: 22 (NYO-3086-1, Pt.II)
PETROW, Henry G., Dietary intake of ^{228}Ra, 20: 148 (NYO-3086-1, Pt.IV)
PETROW, Henry G., Distribution of ^{228}Ra and ^{228}Th in bones of beagle injected with ^{228}Ra, 20: 23 (NYO-3086-1, Pt.III)
PETROW, Henry G., Lead-210 content of some selected foods, 20: 149 (NYO-3086-1, Pt. V)
PETROW, Henry G., Prog. rpt. on radioactivity studies, annual, 12/64–11/65, 20: 146 (NYO-3086-1)
PETROW, Henry G., Radiochemical analysis of Brazilian samples from regions of high natural radioactivity, 20: 150 (NYO-3086-1, Pt. VI)
PETROW, Henry G., Radioactivity of fossil fuels, 20: 152 (NYO-3086-1, Pt.VIII)
PETZOW, Guenter, Constitution of uranium-rich uranium–cobalt–manganese alloys, 20: 874
PETZOW, Guenter, Properties of intermetallic compounds of uranium, 20: 873
PEUCHMAUR, Alphonse, Machines for loading and unloading channels of nuclear reactor, 20: 1402
PFUNDT, G., Photochemical, radiation chemical, and thermal modes of formation of phenanthroxazoles, 20: 397
PHILLIPS, E. A., Spin, hyperfine structure, and new magnetic moment of 21-min ^{52m}Mn, 20: 1204
PIATTI, G., Maintenance of properties of SAP after treatment of fusion of the matrix, 20: 842
PIAZZOLI, A., Photoproduction of π^+ in ^4He and possible existence of an unstable ^4H state, 20: 1210
PICKUS, Milton R., Technique for extrusion forming of brittle and refractory compositions, 20: 796
PIEKARZ, H., Observation of fisson events in mica sandwiches, 20: 652 (INR-647/I-A,VI/PH)
PIEKARZ, J., Observation of fisson events in mica sandwiches, 20: 652 (INR-647/I-A,VI/PH)
PIERAGOSTINI, F., Recovery of Al–Si alloys neutron irradiated at 78°K, 20: 905
PIERQUIN, B., Can and to what extent may radiotherapy be used with pregnant woman with hemopathy?, 20: 199
PIKULEV, A. T., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
PILERI, A., Behavior of DNA synthesis in different phases of S-period in chromosomes of human acute leukemia, 20: 20 (EUR-2451.e)
PILGRIM, D. H., Application of radioisotope techniques to water engineering investigations, 20: 548
PINAJIAN, J. J., Separation of Am and Cm by anion exchange, 20: 439 (ORNL-tr-893)
PINCUS, P., Flux penetration in cylindrical superconducting films. I., 20: 1128
PINDAK, Frank F., Susceptibility of tissue cultures of canine origin to viruses, 20: 4 (LF-26)
PINEL, Jacques, Cyclotron, 20: 945
PINEL, Jacques, Guide device for beam of charged particles produced in an accelerator, 20: 946
PITKANEN, P. H., Argonne Transient Reactor Test Facility, 20: 1542
PITMAN, James C. Jr., Prediction of nearest safe distances for thermal radiation of nuclear weapons, 20: 614
PITT, W. W. Jr., Fused-salt fluoride-volatility process for recovering uranium from spent aluminum-based fuel elements, 20: 442
PITTERLE, Thomas Arthur, Bilinear averaging for diffusion theory parameters, 20: 1140
PIZZETTI, Federico, Transformation of carcinoma to carcinosarcoma after Ra therapy, 20: 211
PIZZINI, S., Electrode overvoltages in molten fluorides. III., 20: 284 (EUR-804.e)
PLESSET, Milton S., Equations of motion and boundary conditions for vapor bubble dynamics, 20: 487
PLETT, Harry, Concentrations of inorganic constituents of the teeth, 20: 27
PLEVE, A. A., Synthesis of fissionable isomer in $^{241}Am(n,\gamma)^{242}Am$ reaction, 20: 1155 (JINR-P-2347)
PLONKA, Andrzej, Radiometric determination of ion self-diffusion mobilities. II., 20: 327
PLONKA, Andrzej, Radiometric determination of ion self-diffusion mobilities. I., 20: 425
PODZIMEK, J., Results of systematic six years' measurement of atmospheric fallout, 20: 537
PODZYAREI, Y. A., Stuckelberg's formalism of a spin-2 field, 20: 1071
POL, Yu. S., Elastic scattering of fast electrons on nuclei with Fermi distribution of charge density, 20: 1156 (JINR-P-2370)
POLIKANOV, S. M., Synthesis of fissionable isomer in $^{241}Am(n,\gamma)^{242}Am$ reaction, 20: 1155 (JINR-P-2347)
POLL, J. D., Vibrational frequency perturbations in Raman spectrum of hydrogen, 20: 300
POLLOCK, Robert E., Proton total reaction cross sections at 16.4 Mev, 20: 1208
POLYNKOVA, A. A., Radium content of a human body, 20: 603
PONOMAREV, L. I., π-Meson absorption processes in hydrogenous material, 20: 980
PONTECORVO, B., Muon K production in heavy hypernuclei, 20: 1225
POPA, M. S., Gamma radiation from interaction of neutrons with iodine nuclei, 20: 1151 (IFA-RN-20)
POPOV, Iv., Regulations governing work with radioactive substances, 20: 602 (JPRS-31747)
POPOV, Iv., Standards of radiation safety, 20: 155 (JPRS-31646)
POPOV, V. S., Reduction of direct product of irreducible representations of group SU(3), 20: 1073
POPOVA, A. I., Radiation polymerization of isobutylene in various solvents, 20: 409
POPOVICI, C., Hollow-cathode effect in cesium vapor, 20: 1087
PORTER, F. T., Low-intensity first-forbidden β-decay branch in ^{45}Ca, 20: 1206
PORTER, James C., Optimal variational method for pair correlations in many-fermion systems, 20: 975
PORTER, R. N., Exchange reactions with activation energy. I., 20: 312
POSPISIL, J., Early diagnosis of acute radiation sickness in domestic animals, 20: 128
POTGIETER, Lorine, Cobalt-60 irradiation unit for agricultural research, 20: 697
POTTER, Ronald, Improvements in or relating to nuclear reactors, 20: 1424
POTTIER, Paul, Method for leaching uranium-containing ores, 20: 451
POUCHOT, W. D., Comparisons of power conversion systems for lunar nuclear power plants, 20: 1516
POUND, R. V., Effect of gravity on γ radiation, 20: 1114
POWELL-SMITH, C., Factors influencing incidence of radiation injury in cervical cancer, 20: 186
POZZI, L. V., Experiments on the radiosensitivity of hematopoietic staminal cells, 20: 96
PRADEL, I., Reduction of n-propylhydroperoxide by serum and organic filtrates of normal and irradiated rats, 20: 54
PRASIL, Z., Degradation spectrum of electrons, electronic excitation spectra of molecules, and primary radiation chemical yield, 20: 365
PREISER, H. S., Prog. rpt. on cavitation damage in liquid metals, 4–5/65, 20: 769 (NASA-CR-54459)
PRESS, Louise P., Genetic factors influencing irradiation protection by bone marrow. V., 20: 138
PRIBIL, R., Chemical identification and selective determination of rare earths in their mixtures, 20: 252
PRICE, J. C., Measurement of small changes in resistance in reactor environment, 20: 694
PRICE, W. C., Inactivation of southern bean mosaic virus by uv light, 20: 126

PRIMAKOFF, H., Theory of muon capture with initial and final nuclei treated as elementary particles, 20: 1207
PROCHAZKA, Rudolf, Device for monitoring radiation intensity of radioactive substances suspended in air, gases, or vapors, 20: 682
PROCHNICKA, Barbora, Chemical protection from ionizing radiation. III., 20: 130
PROEGER, M., Identification of kink bands in plastically deformed lamellar pearlite, 20: 835 (AERE-Trans-1036)
PROKOFEV, P. T., Conversion electrons emitted in reaction $^{169}Tm(n,\gamma)^{170}Tm$, 20: 1223
PROKSCH, E., Differences in anthracene oil radiolysis by γ radiation and by fast neutrons, 20: 356 (SGAE-CH-19/1965)
PRZYBORSKI, Wincenty, Lithium-drifted detectors for β and γ spectrometry, 20: 664
PUGH, J., Handbook of criticality data. I., 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
PULACCI, A., Reactor for organic moderated critical experiments, 20: 1413 (RT/ING(65)4)
PUPKE, H., Anode region of delayed glow discharge in oxygen, 20: 1088
PUPKE, H., Behavior of electrons in stratified low-pressure discharge, 20: 1086
PURCELL, R. H., Accomplishments of Plutonium Recycle Test Reactor, 20: 1458 (BNWL-SA-308)
PURI, R. K., Flux of primary cosmic-ray α particles near geomagnetic equator, 20: 986
PURKAYASTHA, Usha, Microestimation of zirconium with ^{32}P by radiometric procedure, 20: 258
PUSTOVALOV, V. V., Electromagnetic wave scattering in plasma, 20: 1285
PUTZ, F., Determination of ^{239}Pu content in nuclear fuel by neutron transmission technique, 20: 233 (SGAE-PH-28/1965)
PUTZIER, E. A., Plutonium hazards and accident experiences, 20: 154 (RFP-621)
PYLE, I. C., Proposed specification of computing system using remote consoles, 20: 731 (AERE-M-1627)
PYLE, Robert V., Electron capture by high-energy deuterons in gases, 20: 974

Q

QUINN, L. P., Effect of tartaric acid on kinetics of oxidation of uranium(IV) by thallium(III) in aqueous perchloric acid, 20: 319
QUINTILIANI, M., Changes in blood lipids in irradiated rats with reference to age and dose, 20: 77

R

RABIN, S. A., Experimental studies of transient effects in fast reactor fuels. II., 20: 892 (GEAP-4804)
RACAH, Guiulio, Group theory and spectroscopy, 20: 1236
RACZKA, R., Non-compact groups. I., 20: 738
RADOSZEWSKI, Tomasz, Absolute measurements of radioactivity with 4π counter, 20: 666
RAE, E. R., Nuclear physics work with the electron linac, 20: 1233
RAE, H. K., Fission gas and I release into coolant systems from defects in UO_2 fuel elements, 20: 555 (CONF-650407, pp 1-37)
RAE, H. K., Release of fission gases and iodines from defected UO_2 fuel elements of different lengths, 20: 890 (EXP-NRX-21406)
RAEUCHLE, Eberhard, Polarization modifications of microwaves in penetration through low-pressure plasma, 20: 1292
RAEVSKII, V. G., Study of polymer mixture by radiothermoluminescence, 20: 366
RAFIKOV, S. R., Mechanism of radiation polymerization of diphenylvinylphosphine oxide, 20: 408
RAFIKOV, S. R., Radiation polymerization of diphenylvinylphosphine in solid state, 20: 399
RAHILL, W. Joseph, Renal tubular reabsorption of iodide as compared with chloride, 20: 37
RAHM, D. C., Double resonance production by 2.77-Bev/c π^+ mesons on hydrogen, 20: 1019
RAINES, G. E., Fission-product deposition in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
RAIVIO, Ilkka, Sarcoma following radiation for retinoblastoma, 20: 168
RAJU, M. R., Polymer solutions as radiation dose-meters, 20: 391
RAKAVY, G., Total cross sections of photoelectric effect for uranium, 20: 968
RAMAKRISHNAN, Allodi, New mathematical features in cascade theory, 20: 1062
RAMSAY, M. M., Measurement of small changes in resistance in reactor environment, 20: 694
RANDALL, J. D., Nuclear spectroscopy with energy resolution of a part per million, 20: 1252
RAO, C. L., Aqueous chemistry of hafnium(IV) solvent extraction and ion exchange studies, 20: 260
RASMUSSEN, J. O., Very low-energy isomer in the decay of ^{99}Mo, 20: 1159 (UCRL-16306)
RASTOGI, R. G., Lunar tidal oscillations in H and f_0F_2 at equatorial stations, 20: 1109
RASZL, Karoly, Vaporizing reactors with water cooling, 20: 1484
RATEAU, Arthur, Method for dissolving uranium in nitric acid, 20: 276(P)
RATLIFF, J. L., Metallurgical evaluation evaluation of new tungsten product, 20: 879
RAUH, E. G., Equilibrium metal vapor pressures over alkaline-earth carbides, 20: 810 (AERE-R-5011)
RAVI, K. V., Microstructure and properties of martensite formed from cyclically transformed austenite, 20: 754 (UCRL-16121)
RAVIV, Samuel, Method and device electrolytic dissolution depleted uranium fuel elements, 20: 454
RAY, J. A., Atomic and molecular cross sections, 20: 961 (ORNL-3836, pp 67-73)
RAY, M. M., Biguanide complexes of rhenium(V), 20: 320
READ, Jacques B. J., Nuclear-structure effects in high-energy (p,n) reactions, 20: 1213
READ, P. L., Diffusion-sorption pumping, 20: 507
REAGAN, P. E., Fission-gas release from pyrolytic-carbon-coated fuel particles during irradiation at 2000 to 2500°F, 20: 899
REARDON, W. A., PuO_2–UO_2 experiment in the EBWR, 20: 1457 (BNWL-126)
REBHAN, E., One-dimensional plasma flow in crossed electric and magnetic fields, 20: 1294
RECROSIO, A., Influence of the organic Cl content in terphenyl on Fe corrosion and transport, 20: 777
REDMAN, H. C., Experimental animal housing for the fission product inhalation program, 20: 3 (LF-23)
REED, Frank C., Probabilistic methodology for safety analysis of power reactors, 20: 1461 (CONF-650407, pp 1035-56)
REED, Gareth L., Effects of probability of launch success on long-term usage of radioisotopic SNAP units, 20: 725
REED, R. D., Cell model for quantum fluids. III., 20: 1089
REES, C. E., Sulfur isotope effects in hydrogen ion decomposition of thiosulfate, 20: 297
REGNAUT, P., Separation of uranium and plutonium, 20: 445
REGNIERS, P., Treatment of hyperthyroidism, 20: 173
REILLEY, Charles N., Analysis of deuterium oxide–water mixtures, 20: 239
REINES, F., Cross sections for $\nu_e + p \rightarrow \beta^+$ and $\nu_e + D \rightarrow 2n + \beta^+$, 20: 993 (COO-818-70)
REINES, F., Measurement of reaction $\nu_e + p \rightarrow \beta + n$, 20: 992 (COO-818-65)
REMBERGER, V. G., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
REMY, J., Distribution of ^{144}Ce in bone tissue of the rat, 20: 34
RENNER, H., Special thermocouple performance PWR-1, SEED 4, 20: 1477 (WAPD-PWR-TE-166)
RENNER, Joerg, Structure of niobium suboxide, 20: 876
RENNINGER, G. H., Cross-section relations and polarization in a static SU(6) model, 20: 1017
RHODES, D. N., Radiation-induced optical inversion of L-glutamate residues in poly-α,L-glutamic acid, 20: 47
RICE, T. W., Reactor safety modeling techniques based on the accident to SL-1 boiling water reactor, 20: 1455 (AWRE-R-3/65)
RICH, Arthur, Preliminary results of experiment on the positron g factor, 20: 998 (TID-22255)
RICHARDSON, D. M., Chemistry of tritium in controlled fusion devices, 20: 1274 (ORNL-3836, pp 111-16)
RICKARD, W. H., Gamma-emitting radionuclides in Alaskan tundra vegetation 1959, 1960, 1961, 20: 525
RIESEBERG, H., A search for the decay of $\pi^0 \rightarrow 3\gamma$, 20: 1007
RIESSBECK, K. H., Experiences with high-energy radiation at cancer clinic, 20: 205
RIMSHAW, S. J., Separation of Am and Cm by anion exchange, 20: 439 (ORNL-tr-893)
RISSER, J. R., Level assignments in ^{17}O from $^{13}C(\alpha,\alpha)^{13}C$ and $^{13}C(\alpha,n)^{16}O$, 20: 1212
RITCHIE, D. J., Preliminary design of mercury vapor supersaturation experiment, 20: 481 (NAA-SR-Memo-11194)
RITCHIE, R. K., Rotational spectra of TlF by molecular beam electric resonance method, 20: 1327
RITTER, G. L., Plant-scale demonstration of promethium recovery and purification processes, 20: 1551 (RL-SA-53)
RITZ, Heinrich Hugo Ludolf, Nuclear reactor fuel element, 20: 1445
RITZ, Heinrich Hugo Ludolf, Tubular container for nuclear fuel, 20: 1449
RITZOW, H., Pulmonary ventilation after intense irradiation of bronchial carcinomas, 20: 159
RIVERA, Joseph, Prog. rpt. on fallout program, 6–9/65, 20: 521 (HASL-164)
RIVET, Ernest, Reactions (d,α) on ^{12}C, ^{14}N, and ^{16}O induced by 24-Mev

deuterons, 20: 1211
RIVIERE, Anthony Christopher, Linear accelerators of tandem type, 20: 948
ROALSVIG, J. P., Energy levels of ^{143}Pr, 20: 1199
ROBAYE, G., Analysis of $^{6}Li(n,^{3}H)^{4}He$ integrated and differential cross sections, 20: 1180
ROBERTS, B. F., In-pile fission product release experiments: atmospheric effects, 20: 559 (CONF-650407, pp 276-91)
ROBERTS, D. R., Comparisons of power conversion systems for lunar nuclear power plants, 20: 1516
ROBERTS, H. N., Kerr cell photography of a dynamical deuterium plasma produced in 30-kilojoule theta pinch, 20: 1255 (ARL-65-171)
ROBINSON, Bruce B., Modifications of impulse approximation for ionization and detachment cross sections, 20: 976
ROBINSON, G. W., Infrared spectra and intensity enhancements in solutions of hydrogen halides in liquid xenon, 20: 311
ROBINSON, J. C., Modulus effects in metals after low-temperature electron irradiation, 20: 897
ROBINSON, M. C., Effect of pressure on ferromagnetic phase transition of EuO, 20: 1328
ROBINSON, W. G., Dynamic adiabatic curve for uranium, 20: 836 (UCRL-Trans-1213(L))
ROBKIN, M. A., Final rpt. on Pu recycle for H_2O-moderated reactors, 8/65, 20: 1436 (GEAP-4907)
ROBREDO, J., Glass in nuclear technology, 20: 1556
ROCHE, Roland, Belt restraint system for moderator-reflector structure of nuclear reactor, 20: 1405
ROCHE, Roland, Loading machine for nuclear reactors channels, 20: 1391
RODABAUGH, E. C., Prog. rpt. on analysis of information on reinforced openings in pressure vessels, 2/63–2/64, 20: 457 (BMI-X-276)
RODGERS, S. J., Development of medium flowrate, high-purity particluate and iodine filters, 20: 589 (CONF-650407, pp 1204-15)
ROEMER, E., Electrode overvoltages in molten fluorides. III., 20: 284 (EUR-804.e)
ROESCH, W. C., Shadow shield whole-body counter, 20: 659
ROHDE, K. L., Fission product sorption by protective coatings, 20: 573 (CONF-650407, pp 720-9)
ROHLOFF, F., Dose burden in x-ray diagnosis, 20: 182
ROLLAND, P., Instabilities and growing waves, 20: 1094
ROM, Frank E., Gaseous nuclear rocket, 20: 1532
ROMAGNOLI, U., Effect of hyperoxygenation on radiosensitivity of hepatic tissue, 20: 95
ROMAN, Jerzy, Gold–silicon surface-barrier β spectrometer with multi-gard-ring, 20: 665
RON, A., Total cross sections of photoelectric effect for uranium, 20: 968
ROOKSBY, H. P., Perovskite-type rare-earth niobates and tantalates, 20: 844
ROSE, H., Effect of hypericin as sensitizer of biological systems in comparison with optical and ionizing radiations, 20: 119
ROSENBERG, H. S., Fission product release from coated particle fuels under accident conditions, 20: 556 (CONF-650407, pp 56-72)
ROSENKRANZ, H., Emergency dynamic behavior of pressurized-water nuclear power stations, 20: 1495
ROSENKRANZ, H., Utilization of shutdown energy of the turbogenerator for emergency supply in case of an accident, 20: 1492
ROSENTHAL, Wolfgang, Cosmetic irradiation treatment of the face and its dangers, 20: 183
ROSINI, E., Determination of air stability according to Pasquill's criteria for Italian stations, 20: 515 (RT/PROT(65)17)
ROSOFF, Betty, Removal of ^{46}Sc in man, 20: 31
ROTH, D. J., Ratio determination of antimony trisulfide and potassium chlorate by atomic absorption spectrometry, 20: 229 (MLM-1289J)
ROTHBERG, G. M., Magnetic moment of 99-kev first excited state of ^{195}Pt, 20: 1202
ROTTE, K. H., Pulmonary ventilation after intense irradiation of bronchial carcinomas, 20: 159
ROUGE, Pierre, Belt restraint system for moderator-reflector structure of nuclear reactor, 20: 1405
ROUGE, Pierre, Loading machine for nuclear reactors channels, 20: 1391
ROUGE, Pierre, Plane supporting surface for solid, vertically arranged moderator structure of reactor, 20: 1389
ROUGE, Pierre, Solid construction of moderator for nuclear reactors, 20: 1390
ROUSSEL, E., Possibilities offered by γ spectrometry in nondestructive measurements on fuel elements, 20: 236 (AEC-tr-6621)
ROUX, Dominique, Parallel-plate multisection ionization chambers for high-performance reactors, 20: 1357 (ORNL-P-1432)
ROXBURGH, Ian W., Boundary of convective zones in stars, 20: 954
ROZOVSKAYA, N. N., Radiation polymerization of methyl acrylate in ethyl chloride solution, 20: 404
ROZOVSKAYA, N. N., Radiation polymerization of methyl acrylate in triethylamine and tetrahydrofuran solution, 20: 405
RUDY, S. L., Prog. rpt. on cavitation damage in liquid metals, 4–5/65, 20: 769 (NASA-CR-54459)
RUEHLE, M., Significance of electron microscopic contrast appearance of defect agglomerates in neutron-irradiated copper, 20: 906
RUESTER, R., Experimental results on dynamics of the F region, 20: 1099
RUETTIGER, W., Condensation of cellulose cross-linking agents by electron irradiation, 20: 358 (NP-tr-1299)
RUHMANN, Ann G., Serum lactic dehydrogenase levels in adult beagle dogs with internally deposited radionuclides, 20: 112
RUMARY, C. H., Iodine cleanup in steam suppression system, 20: 576 (CONF-650407, pp 776-804)
RUMFELDT, R., Radical and molecular yields in γ-radiolysis of water. III., 20: 393
RUMPOLD, K., Operating Compton spectrometer, 20: 1440
RUSSELL, M. H., Management of polycythemia vera, 20: 189
RUSSELL, Paul S., Biology of tissue transplantation. II., 20: 104
RUTHERFORD, P., Maximal ordering stability problem, 20: 1260 (MATT-370)
RUWE, Dean Melvin, Gamma attenuation coefficients or grains and forages, 20: 716
RYABOVA, V. G., Study of energies of the metal-hydroxyl bonds in molecules CaOH, SrOH, and BaOH, 20: 294 (UCRL-Trans-1239(L))
RYAN, Peter C., Filter pack technique for classifying radioactive aerosols by particle size. IV., 20: 599 (NRL-6306)
RYAN, Robert, Notes on the Schroedinger operator, 20: 1111
RYDE, Nils, Prog. rpt. on non-destructive analysis of irradiated fuel elements, final, 4/65, 20: 231 (NP-15344)
RZANY, Henryk, Slow neutron scattering by CH_3OH and CH_3SH molecules, 20: 325

S

SACHKOV, Yu. V., Evaluation of significance of statistical regularities in elementary-particle physics, 20: 1047
SADOVSKAYA, G. K., Action of fast electrons on structure of poly-vinylchloride, 20: 400
SAGET, P., Pressure vessel of EDF-1 power station at Chinon, 20: 1479
SAGNELL, B., Distributed carrier multiplex system for flexible remote control and telemetry applications, 20: 933 (CERN-65-28)
SAHO, Takeshi, Effect of mitomycin-C on the frequency of chromosome aberrations produced by x rays, 20: 71
SAKAI, Mitsuo, Measurement of conversion electrons from (p,2n) reactions on vibrational nuclei, 20: 1173
SAKAMOTO, Y., Absorption of stopped π^- mesons by ^{12}C nuclei, 20: 1193
SAKURAI, Junji, Thermal glow of some commercial glasses irradiated by uv, x- and γ-rays, 20: 382
SALESSE, Marc, Method of maintaining sheathing contact in hollow fuel elements during nuclear reactor operation, 20: 1450
SALGANIK, R. I., Effect of deuterium substitution on temperature of helix-coil transition in DNA, 20: 14
SAMPAIO, Oliveria A., Constitution of uranium-rich uranium–cobalt–manganese alloys, 20: 874
SAMPSON, W. B., High-field superconducting solenoid for magnetic moment measurements on short-lived particles, 20: 990 (BNL-9490)
SAMSAHL, Knut, Concentrations of inorganic constituents of the teeth, 20: 27
SAMSONOV, G. V., Evaporation of lanthanum hexaboride, 20: 329
SAMUEL, Parkash, Annotated bibliography on the ionosphere, 20: 1103
SANATANI, S., Survey of values of the 2200 m/s constants for four fissile nuclides, 20: 1164
SANDBORG, Alan O., Radiation position detector, 20: 687
SANDERSON, M. J., Diffusion and interactions in the urania–tungsten and urania–molybdenum systems, 20: 339
SANDIFER, C. W., Rejection of NaI pulse pile-up in linac bremsstrahlung measurements, 20: 651 (EGG-1183-2055)
SANDLIN, R., Measured and predicted variations in fast neutron spectrum when penetrating laminated Fe–D_2O, 20: 1304 (AE-196)
SANDLIN, R., Measured and predicted thermal- and fast-neutron fluxes in air-filled annular ducts, 20: 1317
SANDLIN, R., Variations in fast neutron spectrum in massive shields of water and concrete, 20: 1318
SANDLIN, Rolf, Method for prediction of neutron attenuation in annular ducts, 20: 1139
SANDULESCU, A., Alpha-reduced widths on superfluid model with projected wave functions, 20: 1150 (IFA-FT-55)
SANGIUST, V., Delayed neutron precursors in recombiner of L54M reactor, 20: 1539
SANGSTER, W. A., Continuous-support fuel rod spacer system, 20: 1409
SANNIKOV, S. S., Unstable bound states of the Schroedinger equation, 20: 1113
SANO, Masakatsu, Radiation-induced catalytic activity of nickel oxide, 20: 362
SANSREGRET, André, Radiopelvimetry by Swedish method, 20: 187
SANTHOLZER, V., Dose of external γ radiation from deposited fission

products, 1958 to 1963, 20: 533.
SANTHOLZER, Vilem, Nuclear fallout following cessation of test explosions in atmosphere, 20: 536
SANTHOLZER, W., Results of systematic six years' measurement of atmospheric fallout, 20: 537
SANTIAGO DE MORALES, Rosa J., Resonance in radiation effects, 20: 46 (PRNC-40)
SARGENT, W. E., Final safety and hazards report for the SNAP-15A generator, 20: 722 (GA-4554(Rev.))
SARI, C., Preparation and coating of spherical particles of PuO_2 and $(U-Pu)O_2$ mixtures, 20: 747 (EURAEC-1391)
SARIGIANIS, Perry, ERR stack monitor study, 20: 1452 (ACNP-63628)
SASSE, S., Weight optimization of two-material shield for reactor radiation, 20: 1319
SATO, Etsuo, Research in uranium refining, 20: 441
SATO, S., Detection of embrittlement in steels by means of hardness measurements, 20: 860
SAU, Jacques, Generation-recombination noise in surface-barrier nuclear radiation detector, 20: 693 (NP-15172)
SAVAGE, H. W., Prog. rpt. on SNAP-8 corrosion program, 6/65, 20: 773 (ORNL-3859)
SAVIGNONI, R., Comparison between radiological and rectosigmoidoscopic pictures after radiotherapy of cervix carcinoma, 20: 193
SAVIN, A. G., Diffusion of gases in polymers exposed to ionizing radiation, 20: 407
SAVIN, E. P., Isotopic exchange of cyclobutane with deuterium on evaporated metal films, 20: 304
SAVINO, Joseph M., Simulated fuel assembly, 20: 1398
SAVKOVIC, N. V., Survival and recovery of fertility of male rats irradiated with a dose of 600 R, 20: 136
SAWAYANAGI, Shoichi, Deuterium enrichment by dual temperature exchange reaction between hydrogen and water, 20: 264
SAWYER, J. C., Prog. rpt. on elevated-temperature fatigue data on refractory alloys in ultrahigh vacuum, 4–7/65, 20: 824 (NASA-CR-54458)
SAXENA, R. S., Amperometric determination of UO_2^{++} as vanadate, 20: 255
SAYA, P., Reactor for organic moderated critical experiments, 20: 1413 (RT/ING(65)4)
SCALISE, D. T., Nanosecond ferrite-core magnet system for beam switching, 20: 939 (UCRL-16364)
SCARBROUGH, James O'dell, Method of increasing critical current density of hard superconducting alloys and the products thereof, 20: 1121 (Al-Trans-97)
SCHAARSCHMIDT, Alfred, Multiple scattering of γ radiation in expanded scattering media. I., 20: 1321
SCHAARSCHMIDT, Alfred, Multiple scattering of γ radiation in expanded scattering media. II., 20: 1322
SCHAEFER, John P., Secondary isotope effects in the solvolysis of exo-norbornyl bromide, 20: 352
SCHAEFER, L., Problems and experience in producing cast uranium carbide rods, 20: 791
SCHAEFFER, N. M., Neutron and γ radiation penetration into concrete-shielded underground structures, 20: 1310 (RRA-T51)
SCHAEFFER, N. M., Penetration of neutron and γ radiation through the openings of underground structures, 20: 1308 (RRA-T41)
SCHAFER, A. C. Jr., Prog. rpt. on Elk River Reactor operations, semi-annual, 7–12/64, 20: 1453 (ACNP-65532)
SCHAICH, E. L., Identification of iron-bearing inclusions in uranium metal by etching characteristics, 20: 750 (NLCO-965, pp 6.1-8)
SCHALL, H., Resistance of biosynthesis of hemoglobin in chicken reticulocytes to x irradiation, 20: 76
SCHARFF-GOLDHAVER, G., Proton-neutron coupling in odd-odd Re and Ir nuclei, 20: 1145 (BNL-8168)
SCHARMANN, Arthur, Electrical polarization in lead silicate glass after x irradiation, 20: 410
SCHARPENSEEL, H. W., Permanent automatic control of irrigation from above or below by a neutron probe regime, 20: 633
SCHEARER, Laird D., Atomic-collision-influenced gaseous ^3He quantum resonance magnetometer apparatus, 20: 642
SCHEELE, W., Use of radioisotopes in wood technological problems. I., 20: 710
SCHEELE, W., Use of radioisotopes in wood technological problems. II., 20: 711
SCHICHT, Guenter, Heterogeneous, thermal nuclear reactors for insertion into bituminous deposits reached by bore holes, 20: 1526
SCHIESSLE, Walter, Dietary intake of ^{228}Ra, 20: 148 (NYO-3086-1, Pt. IV)
SCHIESSLE, Walter, Distribution of ^{228}Ra and ^{228}Th in bones of beagle injected with ^{228}Ra, 20: 23 (NYO-3086-1, Pt. III)
SCHIESSLE, Walter J., Radiochemical analysis of Brazilian samples from regions of high natural radioactivity, 20: 150 (NYO-3086-1, Pt.VI)
SCHIFF, L. I., Structure of three-nucleon system, 20: 1234
SCHILLER, Robert, Behavior of ion spurs and tracks in irradiated dipolar systems, 20: 370
SCHIMMEL, Wolfgang, Device for detection of defective fuel elements in nuclear reactors, 20: 1396
SCHIMMEL, Wolfgang, Reactor with thickened fuel suspension circulated through tubes, 20: 1447
SCHIMMER, B., Difference spectrum of α particles after β decay of $^8Li \rightarrow {}^8Be$, 20: 1176
SCHINZER, Friedhelm, Metallographic preparation of nuclear fuel particles, 20: 797
SCHLESINGER, G., Fission product retention and plating behavior in liquid sodium systems, 20: 557 (CONF-650407, pp 73-93)
SCHLUEPMANN, K., A search for the decay of $\pi^0 \rightarrow 3\gamma$, 20: 1007
SCHMIDL, J., Neutron and γ radiation monitor for nuclear reactors, 20: 1362
SCHMIDL, J., Transistorized reactor pulse channel with high resolution, 20: 1360
SCHMIDT, George, Beam-plasma interaction and radiating plasma waves, 20: 1267 (NYO-2813-34)
SCHMIDTKE, Martin, Measurement of changes of electric resistance of gold by irradiation with monoenergetic protons of variable energy, 20: 909
SCHMIDT-KUESTER, W.-J., Industrial utilization of radioisotopes, 20: 706
SCHMIDT-ROHR, U., Difference spectrum of α particles after β decay of $^8Li \rightarrow {}^8Be$, 20: 1176
SCHNEIDER, Roger, Residual body burdens and elimination rates in radium dial painters, 20: 147 (NYO-3086-1, Pt.I)
SCHNELL, Jay H., Effects of neutron-γ radiation on late summer bird populations, 20: 17
SCHOENFELD, I., Spectrochemical determination of boron and strontium in reactor waters, 20: 256
SCHOENHERR, Siegfried, Effect of ionizing radiation on system sulfur dioxide–oxygen. IV., 20: 412
SCHONFELD, E., Two-step process for decontaminating low-radioactivity-level process waste water, 20: 1549 (ORNL-3811)
SCHOT, Joanne W., FLAME master control system, 20: 1421 (AD-611775)
SCHRADER, Richard, Effect of ionizing radiation on system sulfur dioxide–oxygen. IV., 20: 412
SCHRANK, G., Proton total reaction cross sections at 16.4 Mev, 20: 1208
SCHREIBER, B., Strontium-90 in upper layers of coastal sediments of the Ligurian Sea, 20: 526
SCHUBERT, Konrad, Constitution of some systems homologous and quasi-homologous to $^{81}T–Ga$. I., 20: 871
SCHUCH, A. F., Crystal structure of normal hydrogen at low temperatures, 20: 1340
SCHULTZ, H. W., Food preservation by irradiation—present status, 20: 719
SCHULTZ, L., Radiogenic, spallogenic, and primordial rare gases in stone meteorites. III., 20: 956
SCHULTZ, N., Preparation and crystal structure of samarium, europium, and ytterbium oxide bromides LnOBr and La_3O_4Br, 20: 869
SCHULTZ, N. B., Removal of low-level radioactive wastes by sanitary water treatment process, 20: 592 (K-C-785)
SCHULTZ, W. W., Measurement of uranium distribution in solid homogeneous critical assembly fuel, 20: 227 (KAPL-M-6448)
SCHULZ, Milford D., Cancer of the eyelid: do's and don'ts of irradiation, 20: 172
SCHULZE HORN, S., Design concepts for core structure of molten salt experimental reactor, 20: 1423
SCHULZE-PILLOT, G., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
SCHUMACHER, Wilhelm W. B., Method for measuring low density atmospheres, 20: 643
SCHUMANN, E., Gonad dose in radiation therapy of non-tumorous diseases, 20: 206
SCHUMANN, E., Variant for mobile transfer containers for sealed γ emitters, 20: 160
SCHUMANN, Winfried Otto, Linear particle acceleration in spherical electromagnetic interacting fields, 20: 955
SCHWAAR, L., Method for β dose rate determinations by means of an end-window counter tube and of absorbers, 20: 661
SCHWARZ, H., Direct observation of nonlinear scattering of electrons by laser beam, 20: 1003
SCHWARZSCHILD, Bertram M., K+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
SCHWEIGERT, B. S., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
SCIBONA, G., The extraction of uranium and plutonium from nitric acid solution by secondary and quaternary ammonium nitrate salts, 20: 437 (RT/CHI(65)21)
SCOTT, Bruce L., Angular distributions for e⁻-H scattering near first inelastic threshold, 20: 970
SCOTT, T. E., Pneumatic-mechanical high-energy-rate extrusion of yttrium, 20: 783 (IS-1227)
SCOTTI, V. G., Electron microprobe analysis of highly radioactive samples, 20: 224
SCOZZAFAVA, R., Average cosine of scattering angle for particles in a

Maxwellian gas, 20: 1135 (RT/FI(65)12)
SEAGRAN, H. L., Irradiation preservation of fresh-water fish and inland fruits and vegetables, 20: 701 (COO-1283-27)
SEARS, John T., Energy loss by fission fragments in nitrogen, 20: 387
SEEBER, J. Martinez, Use of ^{99m}Tc in hepatic scintillography, 20: 197
SEGRE, G., Uranium and fission products release from uranium dioxide, 20: 894 (RT/CHI(65)27)
SEIBOLD, E., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
SEIDENGLANZ, G., Radioactive pharmaceuticals, 20: 200
SEKI, Jisuke, Analytical application of fluorine ion. II., 20: 333
SELF, S. A., Instability and amplification in finite beam-plasma systems, 20: 1261 (ML-1184)
SEMMELROGGE, W. F., Secular equilibrium using ^{144}Ce–^{144}Pr, 20: 444
SENFTLEBEN, Hermann, Effect of electrical fields on transport phenomena in gases, 20: 1085
SEVERSIKE, Leverne Kenneth, Wave propagation in fully ionized plasma with uniform velocity, 20: 1298
SEVERSON, W. J., Comparisons of power conversion systems for lunar nuclear power plants, 20: 1516
SEVOST'YANOVA, N. I., New compounds of rare earths with lithium, 20: 303
SHAKER, M. O., Generalized Porter-Thomas distribution, 20: 1188
SHAKHASHIRI, B. Z., Oxygen-18 exchange reactions between gaseous oxygen and certain oxygen-containing inorganic salts, 20: 422
SHANTA, V., Evaluation of treatment of advanced primary and secondary gingival carcinoma, 20: 175
SHAPIRA, Y., Effects of high magnetic fields on ultrasonic velocity and attenuation in Nb–25% Zr, 20: 863
SHAPIRO, I. S., Space-time quantization in elementary particle theory, 20: 1043
SHAPIRO, Jerome L., Design study of fission-electric cell reactor, 20: 1468 (JPL-TR-32-741)
SHARMA, H. D., Aqueous chemistry of hafnium(IV) solvent extraction and ion exchange studies, 20: 260
SHARMA, R. D., Exchange reactions with activation energy. I., 20: 312
SHARPE, Jack, Monitoring and warning apparatus for contaminations effected by α and β rays, 20: 679
SHAW, A. L., DUNGENESS—from A to B, 20: 1506
SHAW, Jacques, Neutron emissive target, 20: 1143
SHEINKER, A. P., Radiation polymerization of methyl acrylate in ethyl chloride solution, 20: 404
SHEINKER, A. P., Radiation polymerization of methyl acrylate in triethylamine and tetrahydrofuran solution, 20: 405
SHEINKER, A. P., Radiation polymerization of isobutylene in various solvents, 20: 409
SHELBERG, W. E., Radiolytic decomposition of 1,1-dimethylhydrazine, diethylenetriamine and hydyne rocket fuels, 20: 357 (USNRDL-TR-896)
SHEN, Benjamin C., Diffraction scattering of virtual pions and the A_1 enhancement, 20: 1008
SHEPSTONE, B. J., Theoretical growth-rate curves for Vicia faba roots under continuous radiation exposure at low dose rate, 20: 87
SHERA, E. B., Decay of ^{129}Cs, 20: 1200
SHERBOURNE, A. N., Collapse of cylinder/sphere intersecting pressure vessels, 20: 465
SHERWOOD, William A., Carbon-coated electron-transmission window, 20: 509
SHESTOPALOV, V. P., Electromagnetic wave radiation by electron beam moving in a ring waveguide, 20: 1001
SHIELDS, R. P., In-pile fission product release experiments: atmospheric effects, 20: 559 (CONF-650407, pp 276-91)
SHIMIZU, Sakae, Incoherent scattering of γ rays by K-shell electrons, 20: 978
SHINRIKI, Kiichi, Shrinkage of powder compacts during sintering, 20: 755 (IS-Trans-20)
SHIOBARA, Yui, Electrographic determination of Mg in Mg alloys and Zr in Zr alloys, 20: 267
SHIRLEY, D. A., Cerium magnesium nitrate temperature scale from nuclear orientation, 20: 1338
SHIRVAIKAR, V. V., Containment and siting of high power reactors, 20: 1460 (CONF-650407, pp 1015-34)
SHLAER, Simon, Development of energy-independent film badges with multi-element filters, 20: 658
SIBLER, W., Transistorized d-c channels for reactor instrumentation, 20: 1361
SICILIO, Fred, Secular equilibrium using ^{144}Ce–^{144}Pr, 20: 444
SIEVERS, A. J., Isotope shift of low-lying lattice resonant mode, 20: 1339
SIGLER, William F., Prog. rpt. on effects of accumulated Ra on productivity of algae, final, 20: 26 (TID-22322)
SIGMON, W. M. Jr., Shock testing with high-explosive-initiated gas detonations, 20: 1566 (SC-DC-65-1545)
SILER, W. C., Design of BONUS containment structure, 20: 1512
SILIN, V. P., Electromagnetic wave scattering in plasma, 20: 1285
SILIN, V. P., Radiational acceleration of plasma, 20: 1291
SILINI, G., Experiments on the radiosensitivity of hematopoietic staminal cells, 20: 96
SILL, Larry Robert, Seebeck effect of heavy rare earth single crystals, 20: 1343
SILVESTRI, M., Critical survey of the CIRENE project, 20: 1489
SILYAEVA, M. F., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
SIMON, W., Criticality of fuel reprocessing equipment, 20: 591 (GAMD-6623)
SIMONOVA, L. I., Conversion electrons emitted in reaction ^{169}Tm(n,γ)^{170}Tm, 20: 1223
SINGER, P., Lifetime of the η meson, 20: 1005
SINGRU, R. M., Level structure of ^{131}I, 20: 1201
SIRTORI, Carlo, Transformation of carcinoma to carcinosarcoma after Ra therapy, 20: 211
SISMAN, O., Fission-gas release from pyrolytic-carbon-coated fuel particle during irradiation at 2000 to 2500°F, 20: 899
SIZMANN, R., Angular dependence of electron-penetration in monocrystalline copper, 20: 1331
SJODAHL, L. H., Solute-induced grain boundary hardening and the sintering of BeO, 20: 846
SJOEGREN, H., High ionization potential of methane, 20: 351
SKARPAAS, K., All-metal waveguide vacuum gate valve, 20: 949
SKARPAAS, K., Microwaveguide coupling seal, 20: 645
SKELLY, D. W., Paramagnetic resonance of alkyl radicals from dissociative electron attachment in γ-irradiated organic glass, 20: 371
SKULSKI, R. W., Hydrostatic bearing experiments, 20: 461 (RFP-667)
SLIVNIK, J., Purification of elementary fluorine and its filling in steel cylinders, 20: 217 (NIJS-R-446)
SLOANE, Robert B., Appraisal of hazards of dental radiation, 20: 198
SLOTNICK, H., The compatibility of compacted boron carbide in stainless steel–alkali metal systems, 20: 776 (TIM-822)
SLOVOKHOTOVA, N. A., Action of fast electrons on structure of poly-vinylchloride, 20: 400
SLOVOKHOTOVA, N. A., Radiation polymerization of diketene in solid and liquid states, 20: 398
SMALC, A., Purification of elementary fluorine and its filling in steel cylinders, 20: 217 (NIJS-R-446)
SMELTS, Henri B., Derivation of describing function for reactor power level, 20: 1417
SMELTZER, P., Special thermocouple performance PWR-1, SEED 4, 20: 1477 (WAPD-PWR-TE-166)
SMIERZCHALSKA, K., Problem of use of neutron-irradiated phosphorus fertilizers in studies of their effectiveness, 20: 699
SMIRNOV, E. A., Diffusion and thermodynamic characteristics of nickel–chromium alloys, 20: 834 (AERE-Trans-1031)
SMITH, A. B., Compilation of requests for nuclear cross section measurements, 20: 1161 (WASH-1057)
SMITH, A. B., Levels in ^{10}B excited by the ^{9}Be(d,n) reaction, 20: 1194
SMITH, Bob H., Nanosecond ferrite-core magnet system for beam switching, 20: 939 (UCRL-16364)
SMITH, C. V., CROSS PLOT—program for automatic plotting of differential neutron cross section data, 20: 1149 (GAMD-6507)
SMITH, J. C., Critical analysis of the blowdown accident, 20: 570 (CONF-650407, pp 609-40)
SMITH, J. R., Double resonance production by 2.77-Bev/c π^+ mesons on hydrogen, 20: 1019
SMITH, Lawrence H., Cosmic-ray primary electron flux measurement with rigidity above 5 Bv, 20: 983 (COO-818-59)
SMITH, M. J. S., Iodine clean-up in steam suppression system, 20: 576 (CONF-650407, pp 776-804)
SMITH, M. L., Removing fission gases and iodine from reactor exhaust air by fog spray and foam, 20: 1550 (RL-SA-50)
SMITH, Margaret A., Radical termination mechanisms in radiolysis of crystalline choline chloride, 20: 378
SMITH, O. G., Influence of axially non-uniform heat flux on DNB, 20: 492
SMITH, V. A., Testing of ten-ton UF_6 cylinders, 20: 593 (KY-500)
SMORODINSKII, Ya. A., Group-theoretical properties and invariant form of the Schroedinger equation, 20: 1110 (JINR-P-2306)
SMORODINSKII, Ya. A., Integral representations of relativistic amplitudes in the nonphysical region, 20: 1053 (JINR-P-2321)
SNIDER, J. L., Effect of gravity on γ radiation, 20: 1114
SNYDER, B. J., Calculated γ photofractions for well-type scintillation detectors, 20: 676
SOBKOWSKA, Aleksandra, Influence of U(V) ions on oscillopolarographic waves of U(VI) reduction and U(V) oxidation in organic acid solutions, 20: 326
SOBKOWSKA, Aleksandra, The kinetics of U(V) ions disproportionation in organic acid solutions, 20: 328
SOBOLEV, I. A., Organization of centralized removal of radioactive wastes from sites of their accumulation, 20: 1553

SODAN, H., Coincidence measurements in decay of ^{187}W, 20: 1179
SODAN, H., Decay of ^{181}Hf, 20: 1177
SODAN, H., Decay $^{153}Sm(\beta^-)^{153}Eu$, 20: 1178
SOEREMARK, Rune, Concentrations of inorganic constituents of the teeth, 20: 27
SOERGEL, V., A search for the decay of $\pi^0 \rightarrow 3\gamma$, 20: 1007
SOFFA, L. L., Film thickness measurement by x-ray emission and β backscatter techniques, 20: 493
SOINE, T. S., Prog. rpt. on batch electrorefining of Pu, 5/65, 20: 752 (RL-SEP-503)
SOKOLOV, A. A., Development of study of elementary particles as cognition of profound regularities of the microworld, 20: 1046
SOLOVEV, V. G., Non-rotational collective states of deformed even-even nuclei, 20: 1165
SOLOV'EV, V. V., Bremsstrahlung and lifetimes of resonances, 20: 1023
SOMERVILLE, W. B., Hyperfine spin-spin interactions in H_2^+, 20: 314
SONESAN, M., Hollow-cathode effect in cesium vapor, 20: 1087
SONETT, Charles P., Modulation and sampling of hydromagnetic radiation, 20: 914 (NASA-TN-D-2950)
SONETT, Charles P., Solar wind and its interaction with the magnetosphere, 20: 1098
SORENSEN, Leif B., Radioisotope scanning in diagnosis of liver disease, 20: 174
SOSIN, A., Modulus effects in metals after low-temperature electron irradiation, 20: 897
SOUTHERN, E. M., Radiation-induced optical inversion of L-glutamate residues in poly-α,L-glutamic acid, 20: 47
SOVETOV, N. M., Approximate calculation of TWT transverse electron oscillations with dependence of electron mass on velocity, 20: 919
SOWINSKI, M., Observation of fisson events in mica sandwiches, 20: 652 (INR-647/I-A,VI/PH)
SOWINSKI, Mieczyslaw, Lithium-drifted detectors for β and γ spectrometry, 20: 664
SPANN, J. R., High-temperature properties of potassium, 20: 286 (NRL-6233)
SPEIRS, K. K., Metallurgical evaluation of the LACBWR forced-circulation clad piping, 20: 788 (SWRI-1228-73)
SPENCER, Herts, Removal of ^{46}Sc in man, 20: 31
SPINELLI, John, Effect of hypoxanthine on flavor of fresh and stored low-dose irradiated petrale sole fillets, 20: 718
SPIRIN, E. K., Effect of various factors on the anodic peak of uranium in amalgam polarography with electrolysis, 20: 273
SPITSYN, Vikt. I., New compounds of rare earths with strontium and barium oxides, 20: 302
SPITSYN, Vikt. I., New compounds of rare earths with lithium, 20: 303
SPITZIG, W. A., Three-stage hardening in tantalum single crystals, 20: 837
SPRAGUE, C. W., Gas-generating technique for recovering submerged objects, 20: 1567 (SC-RR-65-380)
SPROUSE, G. D., Gamma transitions in ^{57}Fe, 20: 1182
SPURNY, Z., Thermoluminescent dosimetry, 20: 656
SRINIVASAN, S. K., New mathematical features in cascade theory, 20: 1062
SRIVASTAVA, O. K., Thermal decomposition of oxalates of lanthanum and thorium in vacuum, 20: 317
STACEY, A. J., Obtaining isodose curves using film dosimetry, 20: 671
STACHURA, Jerzy, Chemical protection from ionizing radiation. III., 20: 130
STACHURA, Jerzy, Chemical protection from ionizing radiation. IV., 20: 131
STAHL, A., Exact master-equation without random phases in the initial state, 20: 1112
STAMER, P., Analysis of 3587 τ^+ decays, 20: 1011
STANCIU, M., Gamma-gamma angular correlation measurements of thermal-neutron-capture γ rays in ^{200}Hg, 20: 1152 (IFA-RN-21)
STANISLAV, Pshona, Computing effectiveness of recoil proton radiator in a field of isotropic neutron radiation, 20: 654 (NP-15466)
STARA, J. F., Tissue distribution and excretion of ^{137}Cs in the guinea pig, 20: 33
STARY, F., Measurement of nanosecond lifetimes in deformed nuclear levels, 20: 1175
STAUBER, E., Model for evaluating effects of accidental release of radioactive materials from power reactors, 20: 583 (CONF-650407, pp 970-83)
STAVRAKI, G. L., Stuckelberg's formalism of a spin-2 field, 20: 1071
STEEB, Siegfried, Structure of niobium suboxide, 20: 876
STEFANOVSKII, A. M., Acceleration of plasma electrons, 20: 1257 (IAE-769)
STEIN, R. S., Dependence of light scattering by polymer films on polarization angle, and its relationship to randomness of orientation fluctuations, 20: 1572 (TID-22196)
STEINERT, Chistoph, Apparatus for automatic control of nuclear reactors, 20: 1395
STEINKULLER, E. W., High-temperature properties of potassium, 20: 286 (NRL-6233)
STEPANEK, Stanislav, Stress concentrations in nozzle ring of pressure vessel, 20: 1365
STEPIN, L. D., Quantum radio frequency physics, 20: 925
STEUNENBERG, R. K., Preparation of metals by magnesium–zinc reduction. I., 20: 741 (ANL-7057)
STEUNENBERG, R. K., Preparation of metals by magnesium–zinc reduction. II., 20: 742 (ANL-7058)
STEUNENBERG, R. K., Solubility of uranium and plutonium in cadmium–zinc–magnesium melts, 20: 447
STEVENSON, Richard, Effect of pressure on feromagnetic phase transition of EuO, 20: 1328
STICH, Walter, Process and means for removing radioactive components from gases and gaseous mixtures, 20: 1397
STINCHCOMBE, R. A., Iodine cleanup in steam suppression system, 20: 576 (CONF-650407, pp 776-804)
STIRAND, O., Continuous transition from backward to forward ionization wave, 20: 1290
STIRATI, G., Effects of osmotic diuresis on renal clearance of ^{85}Sr and ^{45}Ca in the dog, 20: 30
STOHR, Jacques Andre, Method of maintaining sheathing contact in hollow elements during nuclear reactor operation, 20: 1450
STONE, E. W., Isotopes in industry. Trends in industrial use of radioisotopes and ionizing radiation, 20: 702 (NYO-3337-16)
STONE, J. P., High-temperature properties of potassium, 20: 286 (NRL-6233)
STONE, N. J., Cerium magnesium nitrate temperature scale from nuclear orientation, 20: 1338
STONEKING, Charles E., Prog. rpt. on impact effects on spherical shells, 20: 463 (SC-DC-65-1634)
STOPPA, I. M., Interpretation of biological effect of radio-chemo therapeutic association in treatment of malignant tumors, 20: 194
STORCK, H., Photoallergy and photosensitivity due to systemically administered drugs, 20: 73
STOREBOE, Per B., Prediction of massive washout of nuclear bomb debris, 20: 527
STORHOK, Victor W., Radiation stability of uranium mononitride, 20: 888 (BMI-1731)
STORM, Ellery, Development of energy-independent film badges with multi-element filters, 20: 658
STOTHERS, J. B., Carbon-13 nuclear magnetic resonance spectroscopy, 20: 330
STOVER, Betsy J., Thorium-228 decay series in adult beagles: ^{224}Ra, ^{212}Pb, and ^{212}Bi in blood and excreta, 20: 42
STRACHER, A., Deuterium–hydrogen exchange of muscle proteins, 20: 349
STRASSNER, W., Comparison of effect of mitomen and x rays on ascites cells of Ehrlich carcinoma in mice, 20: 118
STRATTON, R. F., High-current ion-beam production and injection, 20: 962 (ORNL-3836, pp 74-80)
STREATER, R. F., Spontaneous breakdown of symmetry in axiomatic theory, 20: 1070
STREHLOW, R. A., Chemistry of tritium in controlled fusion devices, 20: 1274 (ORNL-3836, pp 111-16)
STREHOBER, Wilhelm, Nuclear superheater reactor, 20: 1519
STROBRIDGE, T. R., Analysis of pulsed refrigeration system, 20: 1263 (NBS-8817)
STROBRIDGE, T. R., Cryogenic aspects of Project Sherwood magnet refrigeration, 20: 1265 (NBS-8846)
STROMBERG, A. G., Effect of various factors on the anodic peak of uranium in amalgam polarography with electrolysis, 20: 273
STRONGIN, Myron, Superconductivity in tungsten films at temperatures near 4°K, 20: 813 (BNL-9479)
STRUTT, M. J. O., Statistical variations of infrared radiation of Ar discharge. I., 20: 1293
STUETZLE, Dietmar, Polarization modifications of microwaves in penetration through low-pressure plasma, 20: 1292
SUBBARAO, E. C., Defect structure and electrical conductivity of ThO_2–Y_2O_3 solid solutions, 20: 843
SUCHER, J., Polarization of a decay particle in a two-step process, 20: 1013
SUCKEWER, S., Measurement of velocity of plasma in plasmotron nozzle, 20: 501
SUDAR, S., SNAP 10A, expansion compensator, 20: 1527 (NAA-SR-9778)
SUESSMANN, G., Paramagnetic fields of nuclei, 20: 1235
SUGIURA, Masahisa, Propagation of hydromagnetic waves in the magnetosphere, 20: 1100
SUGIYAMA, Masataka, Aging mechanism of sintered WC–Co hard metals, 20: 859
SUHUBI, E. S., Stress distribution at two normally intersecting cylindrical shells, 20: 466
SUICA, S., Nuclear power developments in Yugoslavia, 20: 1491
SULLIVAN, Jeremiah David, Vacuum Regge trajectory in scalar-vector field theory, 20: 1081

SULLIVAN, M. F., Mucus-depleting action of bile in small intestine of irradiated rats, 20: 78
SUMP, Kenneth R., Fabrication of shapes by pneumatic impaction, 20: 809
SUNDERMAN, D. N., Critical analysis of the blowdown accident, 20: 570 (CONF-650407, pp 609-40)
SUNDERMAN, D. N., Fission product release from coated particle fuels under accident conditions, 20: 556 (CONF-650407, pp 56-72)
SUPAN, E. C., Magneforming process for fabrication of thin-wall tungsten cylinders, 20: 781
SUTARNO, Determination of crystal structure of $Er_2Ti_2O_7$ by x-ray and neutron diffraction, 20: 298
SUTTER, P. H., Defect structure and electrical conductivity of ThO_2–Y_2O_3 solid solutions, 20: 843
SUTTLE, Andrew D., Method for production of radioactive substances, 20: 730
SUZUKI, Hisashi, Aging mechanism of sintered WC–Co hard metals, 20: 859
SVECHNIKOV, G. A., Causality and determinism in quantum theory, 20: 1048
SVENTSKI, M., Resonance Y_1^* from self-consistency and broken unitary symmetry, 20: 995 (JINR-P-2337)
SVOBODOVA, J., Measurement of soft β-radiation in biological material with aid of liquid scintillators. II., 20: 253
SWANBERG, F. Jr., Hanford mobile whole-body counter, 20: 660
SWANN, C. P., Properties of the state in ^{31}P at 7.14 Mev, 20: 1203
SWANN, P. R., Microstructural aspects of stress-corrosion failure, 20: 779
SWEENEY, W. E. Jr., M1 character of the 17.64 to 16.62 transition in ^8Be, 20: 1197
SYDOR, Michael, Atmospheric neutron spectrum at high altitudes, 20: 988
SYKES, J. B., Identification of kink bands in plastically deformed lamellar pearlite, 20: 835 (AERE-Trans-1035)
SZCZEPKOWSKI, Tadeusz, Chemical protection from ionizing radiation. III., 20: 130
SZCZEPKOWSKI, Tadeusz, Chemical protection from ionizing radiation. IV., 20: 131

T

TABOADA, A., Prog. rpt. on SNAP-8 corrosion program, 5/65, 20: 773 (ORNL-3859)
TABUSSE, E., Extraterrestrial radiations. I. Biological studies, 20: 122
TAITS, M. U., Biochemical exponents of radiosensitivity of central nervous system, 20: 115
TAKAAI, Tetsuya, Electron beam electron melting of refractory metals. III., 20: 858
TAKAHASHI, K., Proton-neutron coupling in odd-odd Re and Ir nuclei, 20: 1145 (BNL-8168)
TAKAHASHI, Yoichi, Uranium monoselenide. Heat capacity and thermodynamic properties from 5 to 350°K, 20: 323
TAKENO, S., Isotope shift of low-lying lattice resonant mode, 20: 1339
TALBERT, W. L. Jr., Energy of isomeric transition in ^{109}Ag, 20: 1174
TALLAN, N. M., Electrical properties and defect structure of zirconia. II., 20: 845
TAMURA, T., Selective sorption reactions of cesium with soil minerals, 20: 1555
TANIFUJI, Shigeyuki, Effect of mitomycin-C on the frequency of chromosome aberrations produced by x rays, 20: 71
TANKA, D., Change of suprarenal function in acute radiation injury, 20: 141
TARKKANEN, Anti, Sarcoma following radiation for retinoblastoma, 20: 168
TASHIRO, Shingo, Skin contamination by radioactive isotopes. III., 20: 40
TATARENKO, O. F., Dynamic determination of elasticity constants of polymeric materials irradiated by γ rays and fast electrons, 20: 406
TAWARA, Hiroyuki, Pulse shortening in duoplasmatron-type ion source, 20: 1289
TAYLOR, Anthony James, Improvements in or relating to control of nuclear reactors, 20: 1373
TAYLOR, C. E., Superconducting minimum-B magnet, 20: 1279 (UCRL-14233)
TAYLOR, G., Effect of high vacuum purification on niobium single crystals, 20: 838
TAYLOR, L. R., Removal of methyl iodide from reactor effluent gases, 20: 279 (CONF-650407, pp 853-68)
TAYLOR, R., Removal of methyl iodide from reactor effluent gases, 20: 279 (CONF-650407, pp 853-68)
TAYLOR, R., Sampling and characterization techniques used in study of I release from irradiated fuel elements, 20: 281 (CONF-650407, pp 1096-1109)
TAYLOR, S., Analysis of 3587 r^+ decays, 20: 1011
TAYLOR, Thomas, Inactivation of enzymes by uv light. V., 20: 51
TEALE, S. S., Equilibrium oxygen pressure over stainless steels and relation to reactor fuel stability, 20: 277 (AERE-R-4942)
TENNEY, G. H., Autoradiography of fuel elements of the Kiwi reactor, 20: 1438
TENREYRO, Elmo A. A., Preparation of sources of mock ^{131}I, 20: 416 (NP-15525)
TEODOROVICH, O. K., Distribution of elements during formation of sintered alloys in W–Ni–Fe system, 20: 865
TEPLITZ, Vigdor L., Self-consistent ρ trajectory in new form of strip approximation, 20: 1012
TERENT'EV, M. V., Regeneration effects and complete experiment in a K^0-meson beam, 20: 1021
TERLETSKII, Ya. P., Problem of spatial structure of elementary particles, 20: 1040
TERRANI, M., Delayed neutron precursors in recombiner of L54M reactor, 20: 1539
THEARD, Leslie M., Effects of additives on radiolysis of cyclohexane vapor at 100°, 20: 377
THEISEN, R., Vanadium as diffusion barrier between aluminum and uranium, 20: 855
THIRUVENGADAM, A., Prog. rpt. on cavitation damage in liquid metals, 4–5/65, 20: 769 (NASA-CR-54459)
THODE, H. G., Sulfur isotope effects in hydrogen ion decomposition of thiosulfate, 20: 297
THOMAS, G. C., A-c response of a saturated ionization chamber, 20: 657
THOMPKINS, K. W., Calculating penetration of neutron and γ radiation into underground concrete structures, 20: 1307 (RRA-M45)
THOMPSON, M. A., Atmospheric oxidation of plutonium metal, 20: 774 (RFP-609)
THORNTON, S. T., N-d scattering–vector polarization of recoil deuterons from polarized neutron beam, 20: 997 (ORNL-P-1607)
THOSAR, B. V., Lifetimes of positronium in polyethylene irradiated by γ rays, 20: 1002
THOURSON, Thomas Lawrence, High-frequency conductivity of plasma, 20: 1300
THUEMMLER, Fritz, Preparation and hot pressing of UN, 20: 799
TIKHOMIROVA, N. S., Diffusion of gases in polymers exposed to ionizing radiation, 20: 407
TILFORD, S. G., Highly ionized atomic spectra, 20: 341
TILL, A. S., Carcinoma of the thyroid, 20: 203
TILLAEV, R. S., Densities of radiation graft copolymers, 20: 401
TIMM, U., Anode region of delayed glow discharge in oxygen, 20: 1088
TIRSELL, Kenneth Glenn, Gamma rays following β decay of ^{124}Sb and ^{134}Cs, 20: 1240
TITOVA, I. N., Radium content of a human body, 20: 603
TITULAER, U. M., Correlation functions for coherent fields, 20: 1063
TOBIAS, Cornelius, Cerebral and cerebellar cortex following damage from ionizing particle radiation, 20: 68
TOCHILIN, E., Photographic detection of fast neutrons, 20: 667
TOMSCHKE, E., Development and testing of radioactive tracer method for measuring the kinetics of erosion and sand displacement caused by surf, 20: 510 (EUR-2167.d)
TONG, L. S., Influence of axially non-uniform heat flux on DNB, 20: 492
TONG, S., CEP. Monto Carlo program for the calculation of first-flight escape probabilities for finite cylinders, 20: 1133 (IDO-17075)
TOPP, N. E., Chemistry of the rare-earth elements, 20: 219
TORIUMI, Isao, Model analysis of aseismic design of reactor building, 20: 1355
TOURTELLOTTE, H. A., Direct observation of nonlinear scattering of electrons by laser beam, 20: 1003
TOUSSAINT, C. J., X-ray spectrographic determination of tantalum in niobium by electron excitation, 20: 246
TOWNLEY, C. W., Fission product release from coated particle fuels under accident conditions, 20: 556 (CONF-650407, pp 56-72)
TOYODA, Kadzuhisa, G., Method of controlling nuclear reactor, 20: 1408
TREILLE, Pierre, Nuclear reactor installation, 20: 1430
TRETYAKOV, O. A., Electromagnetic wave radiation by electron beam moving in ring waveguide, 20: 1001
TRETYAKOVA, S. S., Electromagnetic wave radiation by electron beam moving in ring waveguide, 20: 1001
TRILLING, G. H., K^* production in $K^+ + n$ and $K^+ + p$ reactions, 20: 1010
TRILLING, George H., K^+n charge-exchange scattering at 2.3 Bev/c, 20: 1009
TRILLO, J. M., Irradiation of alumina catalysts, 20: 368
TRIULZI, C., Strontium-90 in upper layers of coastal sediments of the Ligurian Sea, 20: 526
TROETSCH, E., Transformation theory of separation cascades. IV., 20: 448
TROMBE, Felix, Vapor pressures of metals and refractory metalloids. II., 20: 331
TROWELL, O. A., Effect of radiation on activity of reticuloendothelial cells in organ cultures of lymph node and thymus, 20: 85
TROZERA, T. A., Prog. rpt. on mechanical properties of reactor materials, 2–4/65, 20: 819 (GA-6413)
TRZEBIATOWSKI, W., Phase equilibrium in UO_2–Sc_2O_3 and ThO_2–Sc_2O_3

systems, 20: 839
TRZEBIATOWSKI, W., Phase equilibria in the Y_2O_3–Sc_2O_3 system, 20: 840
TRZEBIATOWSKI, W., Phase equilibria in CaO–Sc_2O_3 system, 20: 841
TSAI, Y. S., Differential cross section for $e^+ + e^- \rightarrow W^+ + W^- \rightarrow e^- + \nu_e + \mu^+ + \nu_{\mu\perp}$, 20: 1018
TSANEV, K., Investigations of chronic γ irradiation of heart, liver, and kidneys, 20: 102
TSETLIN, B. L., Radiation polymerization of diphenylvinylphosphine in solid state, 20: 399
TSINTSADZE, N. L., Electromagnetic transformation in nonequilibrium plasma, 20: 1286
TSUCHIDA, T., Magnetic characteristics of compounds of cerium and praseodymium with V/A elements, 20: 309
TSUJI, Waichiro, Properties of graft copolymerized cellulose fiber. II., 20: 363
TUBIANA, M., Can and to what extent may radiotherapy be used with pregnant woman with hemopathy?, 20: 199
TUGOV, I. I., Group-theoretical properties and invariant form of the Schroedinger equation, 20: 1110 (JINR-P-2306)
TUNM, Guenter W., The critical mass of cavity reactors with gaseous fissionable mass for rocket engines, 20: 1531
TURAKULOV, Ya. Kh., Conference on peaceful uses of atomic energy, Taskhkent, 1961, 20: 11 (AEC-tr-6293)
TURBA, F., Resistance of biosynthesis of hemoglobin in chicken reticulocytes to x irradiation, 20: 76
TURNER, J. E., Possible role of momentum in radiation dosimetry. II., 20: 605
TURNER, J. E., Relationship of velocity of charged particle to its RBE, 20: 98
TURNER, James E., Evaluating the radiation therapy patient, 20: 184
TURNER, Oscar A., Experience with chlormerodrin-Hg brain scan: report of 163 cases, 20: 178
TUYN, J. W. N., Neutron dosimetry with Ag-activated phosphate glasses, 20: 628
TYAPKIN, A. A., Joint coordinate-momentum representation of quantum mechanics, 20: 1080
TYSON, W. R., Fiber-strengthened materials, 20: 884
TZEN, Nai-gun, Investigation of the $^3He + {}^3He$ reaction, 20: 1154 (JINR-P-2323)

U

UBEROI, C., Transport processes in multi-component assembly on basis of generalized BGK collision model, 20: 1090
UCHIDA, Tetsuo, Synthesis of ^3H- or ^{32}P-labeled O,O-dimethyl S-(methylcarbamoylmethyl) phosphorodithioate, 20: 423
UDAVCAK, R. J., Development of medium flowrate, high-purity particulate and iodine filters, 20: 589 (CONF-650407, pp 1204-15)
UDAYA SHANKAR RAO, V., Knight shifts and magnetic susceptibilities in rare-earth–tin intermetallic compounds, 20: 861
UEMURA, Tejji, Observations of backscattered γ rays in surface density gage, 20: 629
UENO, Y., Effect of inorganic ions on changes of protein solution by x irradiation, 20: 49
ULLMANN, J. W., Fused-salt fluoride-volatility process for recovering uranium from spent aluminum-based fuel elements, 20: 442
ULRICH, Bruce Truman, π-d production and transverse momentum distributions in high-energy physics, 20: 1031
UMEDA, Iwao, Measurements of dose buildup factors of iron slabs for line isotopic source, 20: 1316
UMEDA, Iwao, Transmission of γ rays through pipe walls, 20: 1320
UMEDA, Takatoru, Aging mechanism of sintered WC–Co hard metals, 20: 859
UMEMOTO, Shunji, $^{234}U/^{238}U$ in seawater from the Kuroshio region, 20: 512
UNGUREANU, C., Isotopic analysis of oxygen by optical spectroscopy, 20: 269
UPHOFF, Delta E., Genetic factors influencing irradiation protection by bone marrow. V., 20: 138
UPPARD, J. E., Shock tube 30 × 18 in., 20: 619 (AWRE-O-50/65)
UPTON, Arthur C., Recording lens opacities, 20: 75
URBACH, V., Kinetics of ion exchange in phosphonic resin Bio-Rex 63, 20: 263
URBANEC, Z., Pyrolysis products of uranium trioxide monohydrates. II., 20: 870
URIST, Marshall R., Short-term retention of ^{85}Sr and estimation of initial ^{90}Sr burdens in humans, 20: 32
USHAKOV, V. D., Radiation polymerization of diketene in solid and liquid states, 20: 398
USMANOV, Kh. U., Densities of radiation graft copolymers, 20: 401
USSELI, A. I., Diffusion length for arbitrarily anisotropic scattering, 20: 1137

V

VACEK, K., Degradation spectrum of electrons, electronic excitation spectra of molecules, and primary radiation chemical yield, 20: 365
VAISBERG, S. E., Diffusion of gases in polymers exposed to ionizing radiation, 20: 407
VAJDA, P., Born-Mayer scattering cross sections for radiation damage calculations, 20: 901
VALAN, Kent J., Radiation-induced block or graft copolymers of methyl methacrylate with isobutylene and ethylene–propylene rubbers, 20: 367
VALLE, G., Relative orientation of the twinned polythiomethylene crystals from trithiane by γ irradiation, 20: 353
VAN CANEGHEM, P., Advantages of treating skin neoplasia with soft x rays, 20: 171
VAN DER MEERSCH, J., Influence of physical parameters on adsorption of ^{131}I by activated charcoals, 20: 278 (CONF-650407, pp 814-29)
VAN DER MERWE, Paul du T., Dynamics of singlet and octet of $D_{3/2}$ meson–baryon composite states, 20: 1057 (UCRL-16366)
VAN DER WOUDE, A., Polarization studies at the Oak Ridge isochronous cyclotron, 20: 1157 (ORNL-P-1616)
VAN DE VORST, A., Influence of molecular weight on radiolytic yield of DNA in solid phase, 20: 420
VAN HERLE, R., Advantages of treating skin neoplasia with soft x rays, 20: 171
VAN OERS, W. T. H., Proton spectra from d + d breakup at 25.3 Mev, 20: 1172
VANPRAET, G. J., Fine structure of giant dipole resonance in ^{16}O as observed by inelastic electron scattering at 180°, 20: 1184
VAN RAEPENBUSCH, F., Treatment of hyperthyroidism, 20: 173
VARADI, Vilmos, Nuclear power plants with water-cooled reactors, 20: 1483
VARGA, I., Immunization experiments with irradiated larvae. III., 20: 70
VARKONYI, Lajos, Research reactors, 20: 1537
VASILEV, L. A., Action of fast electrons on structure of polyvinylchloride, 20: 400
VASUDEVA MURTHY, A. R., Thermal decomposition of oxalates of lanthanum and thorium in vacuum, 20: 317
VASUDEVAN, R., New mathematical features in cascade theory, 20: 1062
VAUGHAN, R. D., Some engineering considerations [on Dungeness A], 20: 1504
VAVILOV, V. S., Radiation defects in semiconductors, 20: 904
VAZQUEZ MARTINEZ, Florencio, Resonance in radiation effects, 20: 46 (PRNC-40)
VENUGOPALAN, M., Light intensity and frequency inversion of the Joshi effect, 20: 920
VENVERLOO, L. A. J., Contamination monitor for hands, clothing, and shoes, 20: 607
VERDINGH, V., Polarographic determination of elements of nuclear interest. I., 20: 249
VERJAAL, A., Radiation myelopathy, 20: 100
VERMEULEN, A., Treatment of hyperthyroidism, 20: 173
VERTES, Paul, Production of U by Mg reduction of UF_4, 20: 761
VESELY, V., Chemical identification and selective determination of rare earths, 20: 252
VEST, R. W., Electrical properties and defect structure of zirconia. II., 20: 845
VETRANO, J. B., Method of increasing critical current density of hard superconducting alloys and the products thereof, 20: 1121 (Al-Trans-97)
VEYSSIE, J. J., Resistivity and magnetic susceptibility of cerium nitride at low temperature, 20: 1332
VIALLARD, R., Estimate of hydrogen isotopes and of their allotropic forms in gaseous state, 20: 237 (NP-tr-1266)
VIARD, J., Dynamic adiabatic curve for uranium, 20: 836 (UCRL-Trans-1213(L))
VIDEIRA, A. L. L., Cross-section relations and polarization in a static SU(6) model, 20: 1017
VIELSTICH, W., Determination of anodic hydrogen–deuterium separation factors on noble metal electrodes, 20: 418
VIGNOLO, Antonio D., Measurement of density by gamma scattering, 20: 623 (NP-15529)
VIJAYARAGHAVAN, R., Knight shifts and magnetic susceptibilities in rare-earth–tin intermetallic compounds, 20: 861
VILLA, Alben, Method for leaching uranium-containing ores, 20: 451
VILLALBA, Rafael J., Damage to small intestine by radiotherapy, 20: 210
VILLEE, F., Influence of molecular weight on radiolytic yield of DNA in solid phase, 20: 420
VINCENS, E., Electric power systems of foreign nuclear power plants, 20: 1507
VINOGRADOV, V. P., Generating high-voltage pulses with use of plasma pinch effect, 20: 1281 (AD-620824)
VITTER, Gerard, Improvement of the melting-without-crucible technique, for refractory oxides, 20: 798

VIVIEN, Jean, Handling apparatus for gas-cooled nuclear reactor installation, 20: 1399
VLADIMIRSKII, V. V., Regeneration effects and complete experiment in a K^0-meson beam, 20: 1021
VOEVODIN, E. N., Separation of Am and Cm by anion exchange, 20: 439 (ORNL-tr-893)
VOGG, Hubert, Method for pre-decontamination of nuclear fuel to be reprocessed, 20: 452
VOHLER, O., Graphite for fuel elements, 20: 852
VOLKOV, A. B., Equilibrium deformation calculations of ground-state energies of 1p shell nuclei, 20: 1170
VOLKOV, D. V., $K \to 2\pi$ decay and SU(3) symmetry, 20: 1022
VON GOELER, S., Perturbation of thermal equilibrium of weakly ionized cesium contact plasmas through wall loss, 20: 1282
VON HOLDT, R. E., Theory of low-energy-electron scattering by polar molecules, 20: 973
VORNHUSEN, Heinz W., Design concepts for core structure of molten salt experimental reactor, 20: 1423
VOS, G., X-ray spectrographic determination of tantalum in niobium by electron excitation, 20: 246
VOVK, D., Dielectric properties of partially deuterated $NaH_3(SeO_3)_2$ single crystals, 20: 1333
VRBA, M., Titration of Rous sarcoma virus on chick embryo chorioallantoic membrane, 20: 103
VREELAND, T. Jr., Impurity effects on basal slip in zinc, 20: 1560 (CALT-473-5)

W

WADA, Takeshi, Radiation-induced polymerization of cyclic dienes, 20: 383
WADACHI, Yoshiki, Skin contamination by radioactive isotopes. III., 20: 40
WAENKE, H., Radiogenic, spallogenic, and primordial rare gases in stone meteorites. III., 20: 956
WAGNER, C. D., Mechanism of radical decay in irradiated polyethylene, 20: 385
WAGNER, F. Jr., Low-intensity first-forbidden β-decay branch in ^{45}Ca, 20: 1206
WAGNER, G. F., Autoradiography of fuel elements of the Kiwi reactor, 20: 1438
WAGNER, H., Effect of hypericin as sensitizer of biological systems in comparison with optical and ionizing radiations, 20: 119
WAGNER, H., Reduction of n-propylhydroperoxide by serum and organic filtrates of normal and irradiated rats, 20: 54
WAGNER, Richard L. Jr., Muon capture in ^3He, 20: 1209
WAHLBECK, P. G., Thermodynamics of scandium–hydrogen system, 20: 322
WAIDELICH, Wilhelm, Heat conductivity of neutron irradiated LiF, 20: 411
WAIT, J. R., Modes of propagation in bounded compressible plasma, 20: 1284
WAKEMAN, J. F., Zero-gravity radiotracer propellant gage, 20: 721
WALKE, Gerald J., Topographic influences on diffusion coefficients at a shoreline site, 20: 539 (CONF-650407, pp 381-93)
WALKER, A., Infrared spectra of anhydrous rare-earth nitrates from 4000-100 cm^{-1}, 20: 308
WALKER, Cecilia M., Variable helium film transfer rates down to 0.5°K, 20: 1125
WALKER, G., Handbook of criticality data. I., 20: 1410 (AHSB(S) HANDBOOK-1(1st.Rev.))
WALKER, J. C., Efficient Moessbauer scattering technique, 20: 1250
WALKER, J. C., Moessbauer scattering in ^{169}Tm, 20: 1251
WALKER, W. R., Metal complexes in solvent extraction studies. III., 20: 261
WALLACE, W. E., Magnetic characteristics of compounds of cerium and praseodymium with V/A elements, 20: 309
WALLACE, W. P., Final safety and hazards report for the SNAP-15A generator, 20: 722 (GA-4554(Rev.))
WALSER, Mackenzie, Renal tubular reabsorption of iodide as compared with chloride, 20: 37
WALSH, Edward Mary, Theoretical and experimental investigation of auxiliary-discharge-type converter, 20: 989
WALTERS, C. T., Critical analysis of the blowdown accident, 20: 570 (CONF-650407, pp 609-40)
WALTERS, Geoffrey K., Atomic-collision-influenced gaseous ^3He quantum resonance magnetometer apparatus, 20: 642
WALTERS, William Bee, Photoproduction of ^{52}Mn, ^{44}Sc, and ^{87}Y nuclear isomers, 20: 1246
WANG, Agnes Shih-chuen Chia, Behavior of radioactive elements produced by α decay in various gases, 20: 427
WANG, Nan-min, Investigation of the $^3He + ^3He$ reaction, 20: 1154 (JINR-P-2323)
WANG, S. M., Metal complexes in solvent extraction studies. III., 20: 261
WARD, Helen L., Radioisotopes in medicine, 20: 164 (TID-3077(Suppl.1))
WARING, J. L., Phase equilibria in system aluminum oxide–tungsten oxide, 20: 848
WARNER, P. C., Development of the Dungeness B design, 20: 1500
WARREN, G. R., Reactor safety modeling techniques based on the accident to SL-1 boiling water reactor, 20: 1455 (AWRE-R-3/65)
WASIM, S. M., Magnetocaloric effects and enthalpy in mixed state of superconducting niobium, 20: 1122
WATSON, D. G., Gamma-emitting radionuclides in Alaskan tundra vegetation 1959, 1960, 1961, 20: 525
WATSON, Donny D., Analysis of angular correlations of radiative transitions and investigation of excited states of ^{35}Cl, 20: 1146 (COO-1120-38)
WATSON, K. K., Application of radioisotope techniques to water engineering investigations, 20: 548
WATSON, P. D., Metallurgical evaluation of the LACBWR forced-circulation clad piping, 20: 788 (SWRI-1228-73)
WATSON, Peter G., Techniques of magnetic-field measurement, 20: 627 (UCRL-16357)
WATTERS, Robert L., Delayed warm-up filament power supply for mass spectrometer with emission current regulation, 20: 641
WEGNER, H. E., Axial and planar effects in energy loss of protons in silicon single crystals, 20: 1334
WEHRLE, G., Provisions to ensure undisturbed operation of nuclear reactor instrumentation, 20: 1363
WEIDENBAUM, B., Irradiation of 0.5-inch diameter, solid-pellet UO_2 fuel rods at 700,000 Btu/hr-ft^2 peak heat flux, 20: 893 (GEAP-5100A)
WEIDENBAUM, B., Release of fission products from UO_2 operating at high power rating, 20: 579 (CONF-650407, pp 885-907)
WEIERSHAUSEN, Walter, Surface ionization and surface oxidation of rare earths on W and Re, 20: 757
WEIMER, K., Maximal ordering stability problem, 20: 1260 (MATT-370)
WEINBERG, David S., Secondary isotope effects in the solvolysis of exo-norbornyl bromide, 20: 352
WEINZIERL, P., Determination of ^{239}Pu content in nuclear fuel by neutron transmission technique, 20: 233 (SGAE-PH-28/1965)
WEINZIERL, P., Operating Compton spectrometer, 20: 1440
WEIR, J. R., Irradiation embrittlement of low-boron type 304 stainless steel, 20: 898
WEISS, Sanford R., Experience with chlormerodrin-Hg brain scan, report of 163 cases, 20: 178
WEISSMANTEL, Chr., Diminution coefficients of elements of atomic numbers 1 to 30, 20: 923
WEISZ, H., Temperature dependence of fading effect in semiquantitative autoradiography by ring-oven method, 20: 251
WELLS, J. H., Design of BONUS containment structure, 20: 1512
WELLS, M. B., Calculating penetration of neutron and γ radiation into underground concrete structure, 20: 1307 (RRA-M45)
WELLS, M. B., Differential dose albedos for calculation of γ reflection from concrete, 20: 1309 (RRA-T46)
WELLS, M. B., Neutron and γ radiation penetration into concrete-shielded underground structures, 20: 1310 (RRA-T51)
WELLS, M. B., Penetration of neutron and γ radiation through the openings of underground structures, 20: 1308 (RRA-T41)
WELLS, Molly, Technique for extrusion forming of brittle and refractory compositions, 20: 796
WENZ, Werner, Actual Thorotrast problem: a liver sarcoma with intraperitoneal bleeding, 20: 123
WENZEL, P., Graphite-moderated water-cooled pressure-tube reactors, 20: 1493
WERNER, L., Coincidence measurements in decay of ^{187}W, 20: 1179
WERNER, L., Decay of ^{181}Hf, 20: 1177
WERNER, L., Decay $^{153}Sm(\beta^-)^{153}Eu$, 20: 1178
WERTH, Glenn C., Plowshare: scientific problems, 20: 474
WESLEY, James Paul, Diffusion of seismic energy in the near range, 20: 547
WESOLOWSKI, Jerome John, Investigation of (d,α) reactions on light and medium nuclei, 20: 1238
WESSEL, E. T., Irradiation embrittlement of pressure vessel steels. II., 20: 833 (WERL-8844-5)
WEST, John M., System for fuel elements failure detection in nuclear reactor, 20: 1406
WESTBROOK, J. H., Solute-induced grain boundary hardening and the sintering of BeO, 20: 846
WESTBROOK, J. H., The sources of strength and brittleness in intermetallic compounds, 20: 887
WESTCOTT, C. H., Survey of values of the 2200 m/s constants for four fissile nuclides, 20: 1164
WESTERN, C. T., Interactions of 14.6-Mev neutrons in iron, ^7Li, and carbon, 20: 1144 (AD-614451)
WESTRUM, Edgar F. Jr., Uranium monoselenide. Heat capacity and thermodynamic properties from 5 to 350°K, 20: 323
WEY, Song-jey, Polarography of uranyl-malate complexes at moderately low

temperature, 20: 295
WHEATLEY, J. C., Experimental properties of liquid ^{3}He at very low temperatures, 20: 1118 (COO-1198-302)
WHEELER, Owen H., Radiolysis of estrone and estradiol, 20: 396
WHEELWRIGHT, E. J., Parametric evaluation of DTPA, EDTA, and HEDTA for ion exchange purification of promethium, 20: 429 (BNWL-69)
WHITE, D. H., Search for spontaneously fissioning isomer of ^{242}Am formed by thermal neutron capture, 20: 1191
WHITE, E. A. D., Perovskite-type rare-earth niobates and tantalates, 20: 844
WHITSTON, O. E., Activation analysis and textile research, 20: 238 (NP-tr-1293)
WHITSTON, O. S., Condensation of cellulose cross-linking agents by electron irradiation, 20: 358 (NP-tr-1299)
WIECHERS, G., Analysis of ^{3}He-nucleus scattering and polarization, 20: 1171
WIESINGER, F., Differences in anthracene oil radiolysis by γ radiation and by fast neutrons, 20: 356 (SGAE-CH-19/1965)
WILBUR, David Wesley, Relationship between chemical bonding and x-ray spectrum: studies with sulfur atom, 20: 291 (UCRL-14379)
WILCOX, G. E., Final rpt. on solid-state detector, 3/65, 20: 646 (AD-614432)
WILEY, D. W., Anomalous deuterium hyperfine splittings, 20: 315
WILHELM, Rolf, Short circuit spark gap for collision current installations, 20: 630
WILIP, Elmar K., Temperature fields in sub-cooled fluid in nucleate boiling, 20: 485 (ANL-Trans-225)
WILKENS, M., Significance of electron microscopic contrast appearance of defect agglomerates in neutron-irradiated copper, 20: 906
WILLIAMS, D. D., High-temperature properties of potassium, 20: 286 (NRL-6233)
WILLIAMS, J. R., Interactions of 14.6-Mev neutrons in iron, ^{7}Li, and carbon, 20: 1144 (AD-614451)
WILLIAMS, Ronald Peter, Nuclear reactor, 20: 1425
WILLIAMS, Ronald Peter, Nuclear reactor with coolant non-return valves in pressure vessel, 20: 1433
WILLIAMS, Ronald Peter, Organic liquid moderated and cooled nuclear reactors, 20: 1429
WILLIAMSON, G. K., Predictions of macroscopic flow characteristics from dislocation behavior in graphite, 20: 885
WILLIARD, H. B., N-d scattering–vector polarization of recoil deuterons from polarized neutron beam, 20: 997 (ORNL-P-1607)
WILLIS, David E., Investigation of seismic wave propagation, 20: 542 (NP-15557)
WILSON, C. R., Irradiation of 0.5-inch diameter, solid-pellet UO_2 fuel rods at 700,000 Btu/h-ft^2 peak heat flux, 20: 893 (GEAP-5100A)
WILSON, G. U., Meteorological implications of measurements of ^{90}Sr in Australia, 20: 523
WILSON, George L., Prog. rpt. on [seismic wave detection], 7/30/65, 20: 543 (NVO-98-9)
WILSON, M. T., New technique for remote weighing, 20: 476 (LA-DC-7150)
WILSON, R. F., What happened to SNAP 10A?, 20: 1530
WINEGARDNER, W. K., Corrosion of Zircaloy-2. Wear and crevice effects, 20: 764 (BNWL-SA-313)
WINKELMANN, R. K., Ultraviolet-induced acanthолysis in pemphigus, 20: 74
WINSON, R. W., Thermal model for use in SNAP system simulation, 20: 1529 (NAA-SR-Memo-10961)
WIRTZ, K., Future utilization of nuclear energy in Europe, 20: 1469 (KFK-359)
WITT, A. F., Impurity distribution in single crystals. I., 20: 1573 (TID-22314)
WITT, F. J., CERL-II. Computer program for analyzing hemisphere-nozzle shells, 20: 459 (ORNL-3817)
WOLBERG, J. R., Analysis of errors associated with determination of spatial harmonics, 20: 1142
WOLF, Alfred P., Reactions of energetic tritium and carbon atoms with organic compounds, 20: 359
WOLFENDALE, A. W., Hunting the neutrino deep underground, 20: 987
WOOD, A. J., Determination of plutonium by potentiometric titration, 20: 222 (AERE-R-4975)
WOOD, D. S., Impurity effects on basal slip in zinc, 20: 1560 (CALT-473-5)
WOOD, Rex C., Development and calibration of the PR-3 flowmeter, 20: 620 (COO-401-118)
WOOD, Robert Manning, Proton bombardment of lanthanum, praseodymium and separated isotopes of tin, 20: 1239
WOODHEAD, J. L., Uranium(IV) nitrate and perchlorate species in tri-n-butyl phosphate solutions, 20: 321
WOODS, Frank W., Gamma attenuation by loblolly pine wood, 20: 1313
WOODSTOCK, Lowell A., Comparison of possible indices of seedling vigor in corn, 20: 109
WRENN, McDonald E., Iron-55 in humans, 20: 153 (NYO-3086-1, Pt.X)
WUENSCHMANN, M., Diminution coefficients of elements of atomic numbers 1 to 30, 20: 923
WYLIE, R. D., Metallurgical evaluation of the LACBWR forced-circulation clad piping, 20: 788 (SWRI-1228-73)

Y

YAKIMENKO, I. P., Thermal radiation of plasma cylinder, 20: 1287
YAKOVLEV, A. F., Determination of water supplies in snow deposits by aerial γ exposure, 20: 549
YAMAMOTO, S. S., Double resonance production by 2.77-Bev/c π^+ mesons on hydrogen, 20: 1019
YAMASHINA, Toshiro, Radiation-induced catalytic activity of nickel oxide, 20: 362
YAMAZAKI, Toshimitsu, Measurement of conversion electrons from (p,2n) reactions on vibrational nuclei, 20: 1173
YAMAZAKI, Toshimitsu, Measurement of pair-production cross section near threshold, 20: 1214
YANG, W. J., Transient heat transfer to laminar Bingham-plastic flow, 20: 490
YAVORSKY, P. M., Prog. rpt. on evaluation of β irradiation of pressurized reactions, 11/63–10/64, 20: 355 (NYO-2978-42)
YEH, C., Cherenkov radiation in inhomogeneous periodic media, 20: 979
YEN, Lu., Average-value theorem in the Moessbauer effect, 20: 1162 (AD-619487)
YONEMOCHI, Osamu, Fused zirconia refractories. III., 20: 867
YORK, Larry B., Bremsstrahlung produced by 0.75- and 1.25-Mev electrons incident on typical Apollo wall sections, 20: 1306 (NASA-TM-X-1140)
YOUNT, D., Scattering of 150- and 300-Mev positrons and electrons from bismuth, 20: 913 (LAL-1142)
YUAN, Luke C. L., Recent trends in particle detection at high energies, 20: 649 (BNL-9543)
YUDITSKII, B. Ya., Effects produced by sodium nicotinate, riboflavin, and folic acid on phagocytosis during x-ray treatment of patients with malignant new growths, 20: 191
YUILLE, W. D., Sampling and characterization techniques used in study of I release from irradiated fuel elements, 20: 281 (CONF-650407, pp 1096-1109)

Z

ZACKAY, Victor F., Conference on high-strength materials, Berkeley, Calif., 6/64, 20: 817 (CONF-710)
ZAKHAROV, V. I., Ademolio-Gatto theorem and supercharged particles, 20: 1072
ZAKRZEWSKI, J., Observation of fisson events in mica sandwiches, 20: 652 (INR-647/I-A,VI/PH)
ZALOUBOVSKY, I. I., Reaction (d,p) of ^{23}Na in energy range from 1.0 to 2.5 Mev, 20: 1185
ZAMORANI, G., Conservation and stability of labeled macromolecules, 20: 2 (EUR-2419.f)
ZARETSKII, D. F., Four-fermion interations and baryon masses, 20: 1074
ZARTMAN, R. E., Geochronologic study of Lone Grove pluton from Llano Uplift, Texas, 20: 532
ZAUSIG, B., Detection of reaction ^{28}Si(n,p)^{28}Al in silicon semiconductor detectors at 14 Mev, 20: 1163
ZEBOUNI, N. H., Magnetocaloric effects and enthalpy in mixed state of superconducting niobium, 20: 1122
ZEBRO, Tadeusz, Chemical protection from ionizing radiation. III., 20: 130
ZEBRO, Tadeusz, Chemical protection from ionizing radiation. IV., 20: 131
ZEMLJIC, A., Purification of elementary fluorine and its filling in steel cylinders, 20: 217 (NIJS-R-446)
ZETLIN, B. L., Mechanism of radiation polymerization of diphenylvinyl-phosphine oxide, 20: 408
ZHDANOV, G. B., Theory and experiment in microworld physics, 20: 1049
ZHOMOV, F. I., Diffusion and thermodynamic characteristics of nickel–chromium alloys, 20: 834 (AERE-Trans-1031)
ZHYDKOV, E. P., Method of finding conventional extrema, 20: 734 (JINR-P-1988)
ZICHA, B., Early diagnosis of acute radiation sickness in domestic animals, 20: 128
ZIELENBACH, William J., Radiation stability of uranium mononitride, 20: 888 (BMI-1731)
ZIGMAN, Seymour, Nucleic acid metabolism in the lens. III., 20: 89
ZIMA, G. E., Vaporization of advanced powerplant metals under vacuum and forced convection conditions, 20: 831 (UCRL-14274)
ZIMMER, K. G., Contribution to radiobiological basis of maximum permissible radiation dose, 20: 107
ZINN, Walter H., Power reactor technology, 20: 1513
ZLATKEVICH, L. Yu., Study of polymer mixture by radiothermoluminescence, 20: 366
ZOBOR, Ervin, Safety problems of reactors, 20: 1353

ZONA, R., Reactor for organic moderated critical experiments, 20: 1413 (RT/ING(65)4)
ZOTSCHEW, W., Electro- and cardiographic studies of radiation-treated patients with mammary gland cancer, 20: 213
ZUCKER, A., Polarization studies at the Oak Ridge isochronous cyclotron, 20: 1157 (ORNL-P-1616)
ZUCKERMANN, M. J., Resonance scattering in impure superconductors, 20: 1127
ZU PUTLIZ, G., Determination of nuclear moments with optical double resonance, 20: 1237
ZUR HORST-MEYER, H., Experiences with high-energy radiation at cancer clinic, 20: 205
ZWICKER, Hartwut, Short circuit spark gap for collision current installations, 20: 630

SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included in cumulative indexes to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Gland and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings, e.g., Amino Acids rather than Acids, Amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases parenthetic modifying terms or inverted headings of the form Neutrons, Fast are used in preference to a direct entry that would result in the scattering of information. Organic compounds are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of Chemical Abstracts, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are alphabetized word-by-word. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out.

Examples:

M-Capture
  see Electron Capture
Magnesium
Magnesium Alloys
Manganese Fluorides
Manganese(II) Fluorides
Mesons
Mesons (π)
Mesons (ρ)
3-Pentanol, 2,4-Dimethyl-
2-Pentanol, 2-Methyl-
2-Pentanol, 4-Methyl-

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Alloys and Other Systems

Multicomponent alloys, except well-known trade names are indexed under a main heading in the form "element alloy" for each element in the alloy. The modifier begins with element symbols for each component arranged alphabetically as if the English name for the element were spelled out.

Example: Copper-Gold Alloy is indexed
  Copper Alloys
    Cu-Au...
  Gold Alloys
    Cu-Au...

Well-known alloys such as Zircaloy-2 are indexed directly to the trade name; cross references referring from each component of the alloy to the entry for the trade name appear in cumulative indexes.

Multicomponent systems of non-metallic elements are indexed in a manner similar to alloys except the main heading used contains the word "Systems" in place of "Alloys."

Example: Silicon–Tungsten Systems are indexed
  Silicon Systems
    Si-W...
  Tungsten Systems
    Si-W...

Multicompound systems and mixtures of compounds are indexed under the main heading for each component com-

pound; the modifiers begin with an alphabetical listing of compound formulas.

Example: Lead Titanate–Lead Zirconate is indexed
Lead Titanates
$PbTiO_3$-$PbZrO_3$...
Lead Zirconates
$PbTiO_3$-$PbZrO_3$...

A mixed system of compounds and elements is indexed using a combined form of the above conventions, e.g., a dispersion of copper and alumina would be indexed

Aluminum Oxides
Al_2O_3-Cu...
Copper Systems
Al_2O_3-Cu..

Physical States and Configurations of Materials

Specification of the physical state, if other than normal, or geometric configuration of the material is included in the modifying phrase, i.e., liquid metals would be indexed to the metal with "liquid" in the modifier, and carbon crucibles would be indexed to Carbon with "crucibles" appropriately placed in the modifier and also to Crucibles if appropriate.

Modifying Phrases

The modifiers appearing under a main heading are written specifically to describe the relation of the item being indexed to that main heading. The modifier, therefore, will generally contain more useful information about that relation than will a title or a phrase written to be used under every main heading assigned to the item. Effort is exerted to begin the modifier with the word judged to be of greatest use to the greatest number of users; this, however, does not obviate the need to consider all modifiers under the main heading(s) of interest.

Modifiers are usually intended to form a meaningful phrase when combined with the main heading. Some are intended to be read following the main heading, e.g., the entry Hydrogen—sorption by charcoal is read "hydrogen sorption by charcoal"; however, as a result of placing the important word first, many modifiers must be arranged for smooth reading, e.g., Formaldehyde—yields in radiolysis of ethyl ether, effects of deuterium on is read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and Uranium—crystal structure of, effect of cooling rate on allotropic transformations in is read "effect of cooling rate on allotropic transformations in crystal structure of uranium." Prepositions are sometimes omitted if no ambiguity results.

Special characters are added to modifiers in the field of physics; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the journal reference number. The value of this identification has been established by the American Institute of Physics.

A

ABDOMEN
particle passage from peritoneal cavity into diaphragmatic lymphatics in, 20: 16
ABSTRACTS
on ionospheric properties, 20: 1103
on radiation shielding, 20: 1305 (AED-C-01-10)
ACCELERATORS
beam extraction systems for, 20: 950(P)
beam focusing device for charged particles in, 20: 946(P)
conference, 20: 943
control of, use of CERN multiplex system for remote, 20: 933 (CERN-65-28)
shielding calculations for high-energy, analysis of, 20: 935 (ORNL-TM-1298)
waveguide vacuum gate valve for, 20: 949(P)
ACCIDENTS
plutonium, environmental contamination from, 20: 154 (RFP-621)
power supply in, use of shut-down energy of turbogenerator for emergency, 20: 1492
safety hazards from plutonium, 20: 154 (RFP-621)
ACETAMIDE, N-METHYL-
exchange reactions between deuterium and hydrogen-bonded N–H groups in, in aqueous solutions, 20: 354
ACETIC ACID
effects on deuterium exchange with hydrogen-bonded N–H groups in *N*-methylacetamide in aqueous solutions, 20: 354
effects on disproportionation of uranium(V), kinetics of, 20: 328
effects on oxidation and reduction of uranium ions in perchloric acid, disproportionation, 20: 326
ethylene glycol ester, radiolysis of, 20: 361
solvent partition between aqueous and organic phases of aliphatic amines in kerosene and xylene, 20: 223 (CEA-R-2760)
ACETIC ACID, [(CARBOXYMETHYLIMINO) BIS(ETHYLENENITRILO)] TETRA-
effects on plutonium-239 excretion, 20: 60(R) (NYO-901-37, pp 33-68)
effects on plutonium contamination in man, therapeutic, 20: 154 (RFP-621)
scandium-46 decontamination in man with, 20: 31
use as elutant in ion exchange separation of light rare earths, 20: 429 (BNWL-69)
use for therapy of plutonium contamination of skin, 20: 24 (RFP-640)
ACETIC ACID, (ETHYLENEDIAMINE) TETRA-
analytical use in determination of rare earths, 20: 252
scandium-46 decontamination in man with, 20: 31
use as elutant in ion exchange separation of light rare earths, 20: 429 (BNWL-69)
ACETIC ACID, (*N*-HYDROXYETHYLETHYLENEDIAMINE) TRI-
use as elutant in ion exchange separation of light rare earths, 20: 429 (BNWL-69)
ACETONE
effects on radioinduced polymerization of isobutylene, 20: 409
acetone–H_2O, deuterium isotope rate effects of solvolysis of substituted bromo- and chlorohydrocarbons in, 20: 336
acetone–H_2O, equivalent conductivity of hydrochloric acid in, 20: 336
ACETONE, THENOYLTRIFLUORO-
complexes with metals and phosphoörganic compounds, synergism in, 20: 261
solvent properties for hafnium chlorides, fluorides, nitrates, and sulfates, 20: 260
ACETONITRILE
acetonitrile–$AgNO_3$, structure of solutions of, 20: 1565(R) (RPI-1999-6)
ACRYLAMIDE POLYMERS
properties and stability of, for use as gamma and proton detectors, 20: 391
ACRYLIC ACID, METHYL ESTER
radioinduced polymerization of, in ethyl chloride at 25 to –78°C, 20: 404
radioinduced polymerization with styrene and acrylonitrile in ethyl chloride at 0 to –78°C, 20: 404
radioinduced polymerization of, in triethylamine and tetrahydrofuran solutions at 25 to –116°C, 20: 405
ACRYLONITRILES
effect on radioinduced polymerization of methyl acrylate in ethyl chloride, 20: 404
radioinduced graft polymerization on polystyrene, polyvinylchloride, perchlorovinyl, and polyvinylalcohol, 20: 401
radioinduced polymerization with methyl acrylate in ethyl chloride at 0 to –78°C, 20: 404
acrylonitrile–butadiene, radioinduced graft polymerization with cotton or rayon, 20: 363
ACTIVATION ANALYSIS
method for determining fertilizer use, effects of phosphorus-32 labeling on, 20: 699
method for, by photoneutron counting, 20: 270
use in textile research, 20: 238(T) (NP-tr-1293)
use of neutron, for trace elements in hair, 20: 268
ACTIVATION DETECTORS
use of gadolinium foils in neutron radiography, 20: 621 (LA-DC-6978)
use of sulfur disk as criticality dosimeter, reduction of sulfur dose threshold in, 20: 647 (AERE-M-1631)
ADENOSINEPHOSPHORIC ACIDS
complexes of adenylic acid oligomers with mercuric chloride, 20: 1575 (TID-16409)
optical properties of adenylic acid and its oligomers, 20: 1575 (UCRL-16409)
protective effects against gamma radiation in *Escherichia coli*, 20: 8(R) (STI/DOC/10/42, pp 23-43)
ADHESIVES
development of organic, 20: 1579(P)
ADRENAL GLANDS
radiation effect on function in rat, protective effects of AET on, 20: 141
shielding, effects on irradiated thymic lymphocytes of, 20: 142
ADVANCED TEST REACTOR
gas loop development and operation for, 20: 746(R) (BNWL-120, pp 6.1-11)
AERIAL SURVEYING
data processing in ARMS II, system for electronic, 20: 520 (CEX-59.4(Pt.3))
AEROSOLS
particle size classification of radioactive, mathematical procedure for filter pack technique for, 20: 599 (NRL-6306)
radioactivity of, detector for monitoring, 20: 691(P)
sorptive properties for radioiodine, 20: 216 (CONF-650407, pp 242-75)
AGE ESTIMATION
methods of, for Great Basin lakes, 20: 546
potassium–argon and rubidium–strontium methods of, for igneous and metamorphic rocks of Llano Uplift, Texas, 20: 532
AGRICULTURE
radiation and radioisotopes in, Russian conference on, 20: 11(T) (AEC-tr-6293)
research in, cobalt-60 irradiation facilities for, 20: 697
AIR
cleaning of, review of conference on, 20: 518
effects on desorption of radioiodine from clays and sediments, 20: 600 (ORNL-P-1581)
effects on fission product release from melted stainless-steel-clad uranium dioxide fuel elements, 20: 559 (CONF-650407, pp 276-91)
flow of expanded plasma of, chemical and thermodynamic processes in inviscid nonequilibrium, (E/T), 20: 1297
neutron attenuation in annular ducts filled with, fast and thermal, (T), 20: 1139
oxidation of Hastelloy X-280 and Haynes 25 alloy at 1120°C, 20: 762(R) (BNWL-120, pp 5.1-18)
reactions with plutonium, 20: 774 (RFP-609)
separation of iodine-131 from, by sorption on activated charcoal, 20: 278 (CONF-650407, pp 814-29)
separation of iodine vapor and methyl iodide from, by activated charcoals, 20: 280 (CONF-650407, pp 869-84)
air–steam, fission product removal by steam suppression system, 20: 576 (CONF-650407, pp 776-804)
ALABAMA
radioactivity levels in fossil fuels from, 20: 152(R) (NYO-3086-1 Pt.VIII)
ALANINE
properties for use as radiation dosimeter, 20: 394
ALASKA
fallout monitoring, 1959 to 1962, 20: 525
ALBUMINS
physiological effects of blood serum, on cells, 20: 61(R) (NYO-901-37, pp 69-73)
use of labeled in hemodynamic studies on patients with Chagas disease, 20: 163(R) (STI/DOC/10/42, pp 71-127)
ALFALFA
gamma attenuation coefficients for, (E/T), 20: 716
ALGAE
effects of accumulated radium on productivity of, 20: 26(R) (TID-22322)
radioactivity from cobalt-60, iron-55 and -59, and strontium-89 in suspended matter in, 20: 612
ALKALI METAL CARBONATES
solvent properties for leaching uranium from low-grade ores, 20: 451(P)
ALKALI METALS
phase diagrams, prediction of multicomponent alkali metal–transition metal, 20: 882
ALKALINE EARTH METALS

phase diagrams, prediction of multicomponent alkali earth metal–transition metal, 20: 882
ALLOYS
analysis for impurities, using spark-source mass spectrometry, 20: 235 (Y-KG-28)
superconducting critical current density in hard, method for increasing, (E), 20: 1121(T) (Al-Trans-97)
ALPHA DECAY
transition widths in deformed nuclei, reduced, (T), 20: 1150 (IFA-FT-55)
ALPHA PARTICLES
detection and measurement of, development of solid-state rate meter for, 20: 646 (AD-614432)
detection and measurement of, engineering drawings of flow-proportional counter for, 20: 674
detection and measurement of, scintillator for, 20: 677(P)
detection and measurement in man, apparatus for, 20: 686(P)
detection in aerosols, semiconductor detector for, 20: 691(P)
detection of, audio pulse type apparatus for, 20: 679(P)
dose in lungs from cigarette smoke, 20: 158
dosimetry, role of momentum in, 20: 605
effects on dipolar systems, behavior of ion spurs and tracks in, (T), 20: 370
effects on rat brain, pathological, 20: 68
emission in beta decay of lithium-8, (E), 20: 1176
energy spectra from (d,α) reactions at 24 Mev, (E), 20: 1211
reactions (α,α) and (α,n) with carbon-13 at 2 to 3.5 Mev, cross sections for, (E), 20: 1212
scattering by nuclei, distorted-wave model in elastic, (E/T), 20: 1238
ALPHA SOURCES
testing sealed radium-226 and thorium-228, leak, 20: 601 (RCC-R-176(Add.))
ALUMINUM
bonding to uranium, method for, 20: 802(P)
corrosion by boric acid and water, weight change in, 20: 1467(R) (IDO-28649)
determination of traces of, in uranium using electron microprobe, 20: 225 (CONF-650810-2)
diffusion in uranium, properties of vanadium as barrier in, 20: 855
dissolution of plates of, mercury-catalyzed nitric acid, 20: 438
effects on basal slip in zinc, 20: 1560 (CALT-473-5)
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
electric properties for cryogenic magnets, 20: 1264 (NBS-8843)
electron elastic scattering by foils of, temperature dependence of, (E), 20: 981
electron plasma resonances in, analysis using photon scattering, (T), 20: 1326 (ORNL-P-1600)
gamma scattering at 1 Mev, Fermi age from multiple, (T), 20: 1322
gamma scattering in, Compton, (T), 20: 1321
heat transfer in cryogenic magnets of, (T), 20: 1264 (NBS-8843)
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
performance in cryogenic magnets, analysis of, (E/T), 20: 1264 (NBS-8843)
properties as shielding material for reactor environmental test chambers, 20: 478
proton total cross sections at 16.4 Mev, (E), 20: 1208
radiation effects on yield stress increase in, at 23°K, 20: 896
radiation effects on 5557 anodized, electron and uv, 20: 910
radiography of, scattering in fast neutron, 20: 667
sorptive properties for fission-product iodine from various environments, 20: 574 (CONF-650407, pp 730-46)
use in gasket seals for ultrahigh vacuum, 20: 468(P)
ALUMINUM ALLOYS
fracture toughness of 7075-T6, 20: 889(R) (BNWL-120, pp 4.1-59)
properties as shielding material for reactor environmental test chambers, 20: 478
Al–Co–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Al–Fe–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Al–Lu, analysis for lutetium, titration method for, 20: 247
Al–Mg, analysis for magnesium, electrographic, 20: 267
Al–Mn–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Al–U, dissolution of plates of, mercury-catalyzed nitric acid, 20: 438 (RT/CHI(65)23)
Al–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Al–U, fabrication of aluminum-clad, quality control in, 20: 795
Al–U, separation of uranium from, by fused-salt fluoride-volatility process, 20: 442
ALUMINUM CARBIDES
deposition on ceramic fuel compacts, 20: 808(P)
deposition on fuel compacts, 20: 804(P)
ALUMINUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
ALUMINUM FLUORIDES
AlF_3–KF–ZrF_4, uses of fused, in fluoride volatility process for separation of uranium from spent fuel elements, 20: 442
ALUMINUM ISOTOPES Al-27
deuteron elastic scattering by, distorted-wave model in, (E/T), 20: 1238
deuteron reactions (d,α) with, distorted-wave model in, (E/T), 20: 1238
deuteron reactions (d,p) at 1.7 to 3.7 Mev, cross sections for, (E), 20: 1244
energy levels of, parity and spin determinations for, 20: 1230
proton inelastic scattering at 17.5 Mev, weak coupling model for, (E/T), 20: 1192
ALUMINUM OXIDES
deformation properties, 20: 886
deposition on ceramic fuel compacts, 20: 808(P)
deposition on fuel compacts, 20: 804(P)
effects on processing plutonium and uranium fuels, 20: 432(R) (EURAEC-1402)
effects on stabilization of zirconia by calcium oxides, 20: 867
extrusion of, development of techniques for, 20: 796
radiation effects on catalyst, used in hydrogen *ortho-para* conversion and hydrogen–deuterium equilibration, 20: 368
sorptive properties of particles of, for radioiodine, 20: 216 (CONF-650407, pp 242-75)
use in electron transmission window, 20: 509(P)
Al_2O_3–CuO_2–lead borate glass, uses for conversion of irradiated fuel swarf to stable ceramic for long-term storage, 20: 1554
Al_2O_3–WO_3, phase studies on, 20: 848
ALUMINUM SYSTEMS
Al–C–Fe–Si–U, radioinduced swelling in, effects of pressure on reactor, 20: 745(R) (BNWL-120, pp 3.1-22)
Al–Fe–Mg–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Mg–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–polyethylene terephthalate, radiation effects of electrons on capacitors of, (E), 20: 692 (NASA-CR-312)
Al–Si, radiation effects on, recovery from neutron-induced, 20: 905
Al–Si, use in bonding aluminum sheaths to uranium fuel elements, 20: 802(P)
AMBERLITES
LA2, solvent properties for mineral acids, 20: 223 (CEA-R-2760)
AMERICIUM
separation by ion exchange, 20: 1352(T,R) (JPRS-31526)
separation from curium by anion exchange, using methanol–nitric acid eluant, 20: 439(T) (ORNL-tr-893)
separation from plutonium aqueous waste by solvent extraction using dibutyl butyl phosphonate, 20: 436 (RL-SEP-518)
separation from plutonium by extraction chromatography, 20: 433 (INP-412/C)
AMERICIUM ALLOYS
Am–Pu, separation of plutonium from, by Lamex process, 20: 443
AMERICIUM ISOTOPES Am-241
alpha decay product ions in surface deposits of, energy loss and charge of, (E), 20: 426
neutron capture by, spontaneously fissioning americium-242 isomer from thermal, (E), 20: 1191
neutron reactions (n,γ) with americium-242 isomer production in, 20: 1155 (JINR-P-2347)
AMERICIUM ISOTOPES Am-242
production of isomeric, by thermal neutron reactions with americium-241, 20: 1155 (JINR-P-2347)
production of spontaneously fissioning isomeric, by thermal neutron capture, (E), 20: 1191
AMERICIUM SULFATES
stability and ion pairing, 20: 299
AMINES
acid-base equilibria of, deuterium effects on, 20: 239
solvent properties of tertiary, for sulfuric acid recovery from aqueous solutions, 20: 1578(P)
AMMONIA
deuterium exchange between hydrogen gas and liquid, 20: 729(P)
radiation effects on dilute aqueous, review on mechanism and rate of, 20: 390
AMMONIUM ACID FLUORIDES
properties for use as fusing agent for decomposition of thorium ore, 20: 333
AMMONIUM COMPOUNDS
use of secondary, in separation of plutonium and uranium by solvent extraction, 20: 437 (RT/CHI(65)21)
AMMONIUM COMPOUNDS, QUATERNARY

p-nitrophenethyltrimethylammonium iodide, decomposition of, carbon-14 isotope effect on, 20: 347(R) (TID-22251)
solvent properties of nitrate, for fertile and fissionable materials and fission products, 20: 446
use in separation of plutonium and uranium by solvent extraction, 20: 437 (RT/CHI(65)21)

AMMONIUM FLUOPHOSPHATES
radiation effects on ESR in single crystals of, 20: 414

AMMONIUM NITRATES
nitrate ion lifetimes in aqueous solutions of, 20: 324

AMMONIUM PLUTONYL FLUORIDES
preparation and lattice constants, 20: 305

AMMONIUM SULFATES
solvent properties for hafnium, 20: 240
$(NH_4)_2SO_4$–NH_4SCN, solvent properties for zirconium, 20: 240

AMMONIUM THIOCYANATES
$(NH_4)_2SO_4$–NH_4SCN, solvent properties for zirconium, 20: 240

AMPLIFIERS
efficiency of, in scintiscanner devices, 20: 562
use of transistorized d-c, for reactor channels, 20: 1361

ANEMOMETERS
design and performance of constant-temperature-difference, for wind measurements, 20: 516 (TID-22278)

ANIMAL CARE
design of facility for, of dogs and small animals, 20: 3 (LF-23)

ANIMAL CELLS
radiation effects on mitosis in rat liver, 20: 95
radiation effects on mouse Ehrlich ascites, comparison of radiomimetics with x, 20: 118
radiation effects on DNA synthesis in mammalian, 20: 121
radiation exposure of single, in tissue culture, 20: 58(R) (NYO-901-37, pp 14-30)
radiosensitivity of gliobastoma, from irradiated primary tumors, in tissue culture, 20: 101

ANIMAL METABOLISM
radiation effects in rat skin, uv, 20: 93

ANIMAL REPRODUCTION
breeding program for experimental rats, 20: 60(R) (NYO-901-37, pp 33-68)
radiation effects on, of insects, *Tribolium castaneum*, 20: 84
radiation effects on, protective effects of desoxyribonucleic acid in rats, 20: 136

ANIMALS
radiation effects immune reactions in, effects of lymph cell number on, 20: 55(R) (EUR-2469.f)

ANION EXCHANGE MATERIALS
sorptive properties of AV-17 and Dowex 1-X8 resins for americium and curium in methanol–nitric acid mixtures, 20: 439(T) (ORNL-tr-893)

ANTENNAS
electric impedance of cylindrical, in plasma, (T), 20: 1253 (AFCRL-65-480)
stresses in shipboard, method for predicting blast-induced dynamic, 20: 617 (AD-611540)

ANTHRACENE
radiolysis of, comparison of gamma and fast-neutron, 20: 356 (SGAE-CH-19/1965)

ANTIBODIES
radiation effects on production of, 20: 104

ANTIGENS
isolation of virus, zonal centrifugation for, 20: 7(R) (ORNL-3883)
radiation effects on immune response to, 20: 104

ANTIMONY
separation from tellurium by extraction chromatography, 20: 433 (INP-412/C)
vapor pressure, 20: 331

ANTIMONY ALLOYS
InSb, transition temperature for spin-density waves in, 20: 921
Sb–Ce, magnetic properties, 20: 309
Sb–Cu–Sn, Mössbauer effects near melting point, 20: 862
Sb–Ge, radiation damage in semiconducting, electron and neutron, 20: 908
Sb–In, impurity striations in non-rotated single-crystal, grown by pulling from melt, 20: 1573 (TID-22314)
Sb–In, properties of cooled photodiode of, for measuring thermal photon noise, 20: 1293
Sb–In, radiation damage in semiconducting, electron and neutron, 20: 908
Sb–Pr, magnetic properties, 20: 309

ANTIMONY CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)

ANTIMONY ISOTOPES Sb-117
pairing energy from spectra of tin (p,n) reactions at 6 to 14 Mev, (E/T), 20: 1239

ANTIMONY ISOTOPES Sb-119
pairing energy from spectra of tin (p,n) reactions at 6 to 14 Mev, (E/T), 20: 1239

ANTIMONY ISOTOPES Sb-121
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173

ANTIMONY ISOTOPES Sb-123
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173

ANTIMONY ISOTOPES Sb-124
beta decay of, circular polarization of gamma rays after, (E), 20: 1240

ANTIMONY SULFIDES
determination in mixtures with potassium chlorates in ignitor beads, atomic absorption spectrophotometric, 20: 229 (MLM-1289J)

ANTINEUTRINOS
interactions with protons, positron spectra from, (E), 20: 992 (COO-818-54)
interactions with protons, cross sections for, 20: 993 (COO-818-70)
reactions with deuterium, cross sections for, 20: 993 (COO-818-70)

ANTIPROTONS
interactions with protons in flight, review of, 20: 1052

APATITES
strontium incorporation into synthetic hydroxy, 20: 232(R) (NYO-901-37, pp 80-4)

ARGON
bismuth-212 and lead-212 transport in carrier gases of, 20: 427
deuteron reactions at 12.9 to 21.0 Mev, electron capture in, 20: 974
diffusion from calcium fluoride–uranium monocrystals, 20: 1324(R) (EURAEC-1428)
diffusion from calcium oxide crystals, 20: 1324(R) (EURAEC-1428)
diffusion from potassium iodide, 20: 1324(R) (EURAEC-1428)
effects on radiolysis of deuterated and normal methane, 20: 379
electric currents in plasma of, (T), 20: 1262 (NASA-CR-309)
electric discharge in, electron density and temperature in stratified low-pressure, (E), 20: 1086
expansion in Laval nozzle of plasma of, isentropic, (T), 20: 1295
flow in plasma jets of, transitions in subsonic, (E), 20: 1084 (SU-247-9)
microwave penetration through plasma of, polarization modifications in, (E), 20: 1292
proton reactions at 1 to 23 kev, metastable 2S hydrogen atom production in, (E), 20: 982
purification in glove boxes, plant for, 20: 475 (AERE-M-1491)
radiation effects on diffusion in polyethylene, 20: 407
thermal radiation from plasma of, fluctuations in, (T), 20: 1293

ARGON ISOTOPES Ar-40
content in igneous and metamorphic rocks, Llano Uplift, Texas, 20: 532

ARGON ISOTOPES Ar-41
separation from reactor exhaust air by foam, 20: 1550 (RL-SA-50)

ARGON SYSTEMS
Ar–D, excited states of solid, 20: 1337
Ar–H, excited states of solid, 20: 1337

ARGONNE RESEARCH REACTOR
fuel evaluation of, methods for, (E), 20: 1533 (CONF-650532-2)

ARMY REACTORS (ML-1)
fuel and materials development for, 20: 1467(R) (IDO-28649)

ARMY REACTORS (SL-1)
reactivity accident in, as basis for safety modeling techniques, 20: 1455 (AWRE-R-3/65)

ASCORBIC ACID
effects on disproportionation of uranium(V), kinetics of, 20: 328
effects on oxidation and reduction of uranium ions in perchloric acid, disproportionation, 20: 326

ASPARTIC ACID
radiolysis of, proton-deuteron exchange in radicals from, (E), 20: 373

ASTRONAUTS
radiation effects on, during space flight, 20: 122

ASTRONOMY
problems of modern, microphysical phenomena in, 20: 1036(T)

ASTROPHYSICS
problems of modern, microphysical phenomena in, 20: 1036(T)

ATHEROSCLEROSIS
radiation effects on development of, in pigeons, 20: 110

ATMOSPHERE
airglow in, data tabulation for July–Dec. 1964, 20: 1108
auroral heights over Churchill, Manitoba, during 1964 and 1965, 20: 1097
convection laws in six-level model of, 20: 517 (UCRL-12415-T)
diffusion coefficients at shoreline site, topographic effects on, 20: 539 (CONF-650407, pp 381-93)
diffusion experiments on French nuclear sites, 20: 540 (CONF-650407, pp 394-404)
diffusion in, tracer studies using radon-222, 20: 528
diffusion of radioactivity release from Carolinas-Virginia Tube Reactor, map overlays for, 20: 561 (CONF-650407, pp 439-54)

diffusion parameters, method for rapid measurement of, 20: 514 (CONF-650407, pp 429-38)
fallout contamination at Argonne, New York, and New Zealand, 20: 521(R) (HASL-164)
fission product dispersion from reactor accident, calculations, 20: 560 (CONF-650407, pp 362-80)
fission product release from nuclear excursions into, 20: 563 (CONF-650407, pp 497-511)
fission product release from reactor accidents to, techniques for limiting, 20: 585 (CONF-650407, pp 1000-14)
radioactivity over Barrow, Alaska, from Chinese nuclear test, 20: 531
radioisotope distribution in, from nuclear excavation in basalt, 20: 613
radon-222 release into, from soils, 20: 528
rotational temperatures from 80 to 160 km in auroral zone, (E), 20: 1096
sampling of, flowmeter design for, 20: 620 (COO-401-118)
stability criteria at Italian stations, 20: 515 (RT/PROT(65)17)

ATMOSPHERE EXPOSURE CHAMBERS
design for carbon-14-dioxide inhalation studies, 20: 58(R) (NYO-901-37, pp 14-30)

ATMOSPHERES
purification of argon in glove boxes, plant for, 20: 475 (AERE-M-1491)
radioactivity in, from fossil-fuel plants, 20: 152(R) (NYO-3086-1 Pt.VIII)

ATOMIC ENERGY
bibliography of bibliographies on, Aug.-Sept. 1965, 20: 1569 (TID-3731)
book: *The Architect in the Nuclear Age*, 20: 1577
research contracts sponsored by International Atomic Energy Agency, 1965 report on, 20: 1568(R) (STI/DOC/10/42)

ATOMIC ENERGY COMMISSION
non-nuclear technology, transfer to industry, 20: 1564 (ORO-629)

ATOMIC EXPLOSIONS
effects of high-altitude, on geomagnetic fields, (T), 20: 1102
effects on geomagnetic fields and ionosphere, (T), 20: 1101
effects on shipboard antennas, method for predicting, 20: 617 (AD-611540)
energy flow from underground, diffusion theory of seismic, 20: 547
fallout from Chinese, particle size and specific activity in, 20: 535
radioisotope distributions in air and ground debris from, in basalt, 20: 613
seismic wave propagation from, 20: 542 (NP-15557)
seismic wave propagation from Bilby, 20: 545
shock waves from, stresses in hard rocks from, 20: 495
shock waves from, effects on hard rocks and underground structures, 20: 496
thermal radiation dose from, 20: 614
use in excavation of Isthmian sea-level canal, 20: 471 (PNE-1999)
use in excavation of Isthmian sea-level canal, general construction plan for, 20: 472 (PNE-2005)
use in excavation of Isthmian sea-level canal, on-site survey program for, 20: 473 (PNE-2006)
use of underground, Plowshare studies of, 20: 474
use to stimulate natural gas reservoirs, Gasbuggy experiment on, 20: 470 (PNE-1000)
uses in mining, research program on chemical, 20: 469(R) (ORNL-TM-1275)

ATOMIC MODELS
for one-electron excited states, (T), 20: 960 (AROD-2810.18)
quantum and correlation corrections to Thomas-Fermi-Dirac, 20: 972

ATOMIC PHYSICS
electron screening effects in Coulomb wave functions, (T), 20: 967

ATOMIC WEAPONS
fallout contamination from, meteorological factors affecting, 20: 527

ATOMS
collisions of, directory of international workers on, 20: 1563 (ORNL-AMPIC-2)
energy levels of, models for one-electron, (T), 20: 960 (AROD-2810.18)
exchange reactions with diatomic molecules, collision dynamics of, 20: 312
excitation and ionization cross sections for, impulse approximation for, 20: 976
model for, quantum and correlation corrections to Thomas-Fermi-Dirac, 20: 972
reaction density of hot, energy-dependent, (T), 20: 966
spectra of highly ionized, emission, 20: 341
wave functions for, screening effects in Coulomb, (T), 20: 967
x ray absorption by, excited states from, (T), 20: 960 (AROD-2810.18)

AURORAL STORMS
heights over Churchill, Manitoba, during 1964 and 1965, 20: 1097
rotational temperatures from 80 to 160 km, (E), 20: 1096

AUSTRALIA
cesium-137, potassium-40, radium-226, and strontium-90 contents of natural and processed materials in, 20: 156
fallout deposition in, meteorological factors, 20: 523

AUTOPSIES
of radioactive cadavers, procedures for, 20: 58(R) (NYO-901-37, pp 14-30)

AUTORADIOGRAPHY
contrast factors for, 20: 13
method of, for measuring fission density distribution in reactor fuel elements, 20: 1438
of cerium-144 in undecalcified serial sections of rat bone, 20: 34
technique using fluid emulsion for, 20: 62(R) (NYO-901-37, pp 74-9)
temperature dependence of fading effect in semiquantitative, by ring-oven method, 20: 251

AVR REACTOR
electric system of, design review, 20: 1507

B

BACTERIA
binding site localization in *Micrococcus radiodurans*, 20: 6(R) (NYO-3319-7)
content in irradiated fish, effects on flavor alteration by hypoxanthine, 20: 718
DNP extraction from *Micrococcus radiodurans*, 20: 6(R) (NYO-3319-7)
radiation effects on DNA in, 20: 45(R) (EUR-2471.1)
radiosensitivity of *Streptococcus faecium*, 20: 69
radiosensitivity of *Serratia marcescens*, protective effects of humidity and inositol against, 20: 99

BACTERIOPHAGES
induction in *Escherichia coli*, ultraviolet, 20: 127
radiation effects on mutations in, gamma and x, 20: 80

BALANCES
description of, for remote weighing in hot cell, 20: 476 (LA-DC-7150)
design for weighing fuel-pellet column, 20: 1444(P)

BARITE CONCRETES
gamma dose buildup factors for, (T), 20: 1311 (RT/PIMA(65)2)

BARIUM CARBIDES
preparation and properties of di-, 20: 810 (AERE-R-5011)
vaporization of, 20: 810 (AERE-R-5011)

BARIUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)

BARIUM HYDROXIDES
bond energy of BaOH, 20: 294(T) (UCRL-Trans-1239(L))

BARIUM ISOTOPES Ba-132
energy level structure, (E), 20: 1173

BARIUM ISOTOPES Ba-133
use in sources of mock iodine-131, 20: 416 (NP-15525)

BARIUM ISOTOPES Ba-140
distribution from nuclear excavation in basalt, 20: 613
separation from irradiated chromium–uranium droplets by solvent extraction using molten magnesium, kinetic studies, 20: 292 (UCRL-16173)

BARIUM OXIDES
$BaO–La_2O_3$, phase studies, 20: 302
$BaO–Pr_2O_3$, phase studies, 20: 302
$BaO–Sm_2O_3$, phase studies, 20: 302
$BaO–Yb_2O_3$, phase studies, 20: 302
$CeO_2–BaO$, phase studies, 20: 302

BARIUM SULFIDES
BaS–rare earth sulfides, crystal structure of solid solutions in, 20: 332

BARIUM TITANATES
sintering of powders of, 20: 755(T) (IS-Trans-20)

BARLEY
radioinduced chromosome aberrations in seeds of, 20: 97

BARRIERS
pore size in, determination of, 20: 728(P)

BARYONS
interactions of spin-½, N/D method for hyperon (Ω^-) generation in exchange, (T), 20: 1014
interactions with mesons, testing SU(6) symmetry by, (T), 20: 1006
interactions with mesons, broken W(3) symmetry model for, 20: 1075
interactions with pseudoscalar mesons, SU(6) model for cross sections for, 20: 1017
mass spectrum of, SU(3) model for, 20: 1074

BARYONS, RESONANCE
decay of Ξ^* (1820), SU(3) symmetry for, (E/T), 20: 1025
decay of, resonance widths and SU(3) symmetry predictions for strong, (E/T), 20: 1025
model for Y_1^*, self-consistent, (T), 20: 995 (JINR-P-2337)
parity and spin of decaying Y* and Y*K* states of, (T), 20: 1078
production of N* (1238) and Y_1^* (1385), SU(6) in weak, 20: 1020
production of N^{*--} and N^{*++}, in antiproton-proton interactions in flight, (T), 20: 1052
production of N*, in meson (π^+)-proton interactions at 2.77 Bev/c, (E), 20: 1019

symmetry for $D_{3/2}$ baryon-meson composite states, dynamics of multiplets in, (T), 20: 1057 (UCRL-16366)
BEACONS
design of radioisotope-powered underwater acoustic, engineering drawings for, 20: 726
BEANS
radioinduced chromosome aberrations in seeds of, 20: 97
BEARINGS
performance of tilting-pad gas-lubricated, at high speeds and high and low ambient pressures, 20: 458(R) (NYO-2512-15)
BEHAVIOR
radiation effects on learning, of Rhesus monkeys, 20: 92
BELLOWS
design and properties of refractory alloy, for valve in potassium corrosion loop, 20: 770(R) (NASA-CR-54477)
BENZANTHRACENE
effects in female rats, carcinogenic, 20: 60(R) (NYO-901-37, pp 33-68)
BENZENE
effects on radiolysis of cyclohexane vapor at 100°C, mechanism of, 20: 377
effects on radiolysis of monolmine of phenanthrene-9,10-quinone, 20: 397
BENZENE, BROMO-
radiation effects on, neutron, 20: 376
reactions of recoil bromine-82 in, 20: 376
BENZENE, (1-BROMOETHYL)-
substituted, deuterium isotope rate effects on solvolysis in acetone–water and ethanol–water mixtures, 20: 336
BENZENE, BUTYL-
radioinduced cracking at high pressure and temperature of *tert*-, beta, 20: 355(R) (NYO-2978-42)
tritium exchange of *tert*-, with water, 20: 347(R) (TID-22251)
BENZENE, CHLORO-
hydrolysis, 20: 777
pyrolysis, 20: 777
radiolysis, 20: 777
BENZENE, (1-CHLOROETHYL)-
substituted, deuterium isotope rate effects on solvolysis in acetone–water and ethanol–water mixtures, 20: 336
BENZENE, ETHYL-
tritium exchange with water, 20: 347(R) (TID-22251)
BENZHYDROL
reactions with benzophenone, carbon-14 isotope effect on equilibrium of, 20: 347(R) (TID-22251)
BENZOIC ACID, *p*-(HYDROXYMERCURI)-
binding sites in *Micrococcus radiodurans*, localization of, 20: 6(R) (NYO-3319-7)
BENZONITRILE
benzonitrile–$AgNO_3$, structure of solutions of, 20: 1565(R) (RPI-1999-6)
BENZOPHENONE
reactions with benzhydrol, carbon-14 isotope effect on equilibrium of, 20: 347(R) (TID-22251)
BENZOQUINONE
effects on radioinduced polymerization of methyl acrylate in triethylamine at –78°C, 20: 405
BENZYLAMINE, DIMETHYL-
decomposition of, deuterium effects on, 20: 239
BERYLLIUM
plastic deformation and consolidation of polycrystalline, at –25 to 500°C, 20: 856
use in neutron emissive targets, 20: 1143(P)
vaporization of, under vacuum and forced convection conditions, (T), 20: 831 (UCRL-14274)
BERYLLIUM CARBIDES
deposition on ceramic fuel compacts, 20: 808(P)
deposition on fuel compacts, 20: 804(P)
BERYLLIUM ISOTOPES Be-8
energy level transition in, multipolarity of, (E), 20: 1197
energy levels of, deformation effects in, (T), 20: 1170
BERYLLIUM ISOTOPES Be-9
deuteron reactions (d,n) at 2.6 to 7.0 Mev, boron-10 energy levels from, (E), 20: 1194
electron inelastic scattering by, form factor for M1 transition in, (T), 20: 1222
BERYLLIUM ISOTOPES Be-10
deuteron elastic scattering by, distorted-wave model in, (E/T), 20: 1238
BERYLLIUM ORES
processing for beryllium oxide separation, 20: 453(P)
BERYLLIUM OXIDES
deformation properties, 20: 886
deposition on ceramic fuel compacts, 20: 808(P)
deposition on fuel compacts, 20: 804(P)
grain boundary hardening of sintered, effects of calcium, magnesium, and zirconium oxides on, 20: 846
separation from ores, 20: 453(P)
thermal conductivity at 1000 to 2200°C, 20: 820 (GE-TM-64-10-4)
thermal properties to melting point, 20: 878
BETA DECAY
beta polarization and scattering asymmetries from, method for analyzing, (T), 20: 1249
coupling-constant renormalization in, sum rules for axial-vector, 20: 1066
BETA PARTICLES
absorption by elements of atomic numbers 1 to 30, 20: 923
detection and measurement of, development of solid-state rate meter for, 20: 646 (AD-614432)
detection and measurement of, engineering drawings of flow-proportional counter for, 20: 674
detection and measurement in fluid samples, apparatus for, 20: 685(P)
detection and measurement of, ionization chamber for, 20: 688(P)
detection of, audio pulse type apparatus for, 20: 679(P)
dosimetry using end-window tubes, 20: 661
dosimetry using thin plastic phosphors in scintillation counters, 20: 663
effects of, from thymidine labeled with carbon-14 or tritium in mice, carcinogenic, 20: 66 (TID-22292)
effects on aluminum-polymer-sandwich capacitors, (E), 20: 692 (NASA-CR-312)
effects on high-pressure high-temperature chemical reactions, 20: 355(R) (NYO-2978-42)
effects on polycythemia, therapeutic, 20: 189
scattering of, use for film thickness measurements, 20: 493
BETA SOURCES
design for exposure of single cells in tissue culture, 20: 58(R) (NYO-901-37, pp 14-30)
detection and measurement of, performance of 4π counters for, 20: 666
use for phosphor activation in light sources for mines, 20: 704
uses in zero-gravity propellant gage, 20: 721
uses of strontium-90, as power source for underwater acoustic beacon, 20: 726
BETA SPECTROSCOPY
analysis of Mott technique for, in polarization and scattering asymmetries, (T), 20: 1249
detectors for, performance of lithium-drifted, 20: 664
detectors with multi-gard-ring for, performance of gold–silicon surface-barrier, 20: 665
BEVERAGES
cesium-137, potassium-40, radium-226, and strontium-90 contents in, in Australia, 20: 156
BIBLIOGRAPHIES
of bibliographies on atomic energy literature, Aug.-Sept. 1965, 20: 1569 (TID-3731)
of nuclear debris studies, 20: 521(R) (HASL-164)
on branch connections and reinforced openings in pressure vessels, 20: 457(R) (BMI-X-276)
on carbon-13 NMR spectra, 20: 330
on degasification of metal surfaces by electron bombardment, 20: 915 (ORNL-TM-1166)
on determination of nuclear moments using optical double resonance, 20: 1237
on Elk River Power Reactor, 20: 1453(R) (ACNP-65532)
on fabrication and hot pressing of uranium mononitride, 20: 799
on industrial uses of radioisotopes and radiation, 20: 702 (NYO-3337-16)
on intergranular corrosion cracking in austenitic stainless steel, 20: 767(R) (GEAP-4915)
on ionospheric properties, 20: 1103
on isotope applications to study of organic reaction mechanism, 20: 348
on molybdenum and tungsten, 20: 753 (SB-415(Suppl. 1))
on multicomponent transition-metal phase diagrams, 20: 882
on non-rotational collective states of deformed even-even nuclei, 20: 1165
on optical techniques for study of phase boundaries, 20: 290 (UCRL-11997)
on radiation shielding, 20: 1305 (AED-C-01-10)
on radioisotopes in medicine, 20: 164 (TID-3077(Suppl.1))
on research sponsored by International Atomic Energy Agency, 20: 1568(R) (STI/DOC/10/42)
on seismic wave propagation from earthquakes and explosions, 20: 542 (NP-15557)
on space biology, 20: 56 (NASA-SP-7011(15))
on space medicine, 20: 56 (NASA-SP-7011(15))
on strengthening mechanisms in intermetallic compounds, 20: 887
on thermoluminescent dosimetry, 20: 656
on use of radioisotopes in wood technology, Part I, 20: 710
on uses of radioisotopes in wood technology, Part II, 20: 711
BIG ROCK POINT POWER REACTOR

atmospheric dispersion at site of, smoke plume studies of, 20: 539 (CONF-650407, pp 381-93)
heat transfer and stability in, oscillation tests of, 20: 1465(R) (GEAP-4894)
BIGUANIDE
complexes with rhenium, properties and spectra of, 20: 320
BILE ACIDS
physiological effects in rat intestine, 20: 78
radiation effects on excretion of, by liver in rats, tracer study, 20: 78
BIOCHEMISTRY
radiosensitivity of central nervous system, 20: 115
BIOLOGICAL MATERIALS
analysis for carbon-14 and tritium by oxidation and scintillation counting, 20: 253
analysis for cesium-137 and strontium-90, radiochemical, 20: 218(R) (STI/DOC/10/42, pp 1-22)
analysis for copper by neutron activation methods, 20: 254
BIOLOGICAL MODELS
for tumor growth rate, 20: 57(R) (NYO-901-37, pp 7-13)
BIOLOGICAL SYSTEMS
polarographic analysis, 20: 44 (COO-1148-98)
radiation effects on Hypericin-sensitized, 20: 119
radiation effects on, during space flight, 20: 122
radiation effects on, protective effects of colloidal sulfur, 20: 137
spectrophotometric analysis, 20: 44 (COO-1148-98)
BIOLOGY
radiation and radioisotopes in, Russian conference on, 20: 11(T) (AEC-tr-6293)
BIOPHYSICS
nomenclature of photometry units, 20: 15
BIRDS
radiation effects on populations of, ecological, 20: 17
radiation effects on atherosclerosis development and lipid metabolism in pigeons, 20: 110
BISMUTH
electron and positron scattering at 150 and 300 Mev, cross sections for, (E), 20: 913 (LAL-1142)
vapor pressure, 20: 331
BISMUTH ALLOYS
Bi–Pb, cavitation effects on alloys at 500 and 1500°F, 20: 771 (NP-15558)
BISMUTH ISOTOPES Bi-212
metabolism in beagles from thorium-228 decay, 20: 42
transport in carrier gases, 20: 427
BLADDER
carcinoma etiology and pathology of, 20: 60(R) (NYO-901-37, pp 33-68)
BLAST EFFECTS
on re-entry vehicle, test for, 20: 462 (SC-DC-65-1554)
stresses induced in shipboard antennas, method for predicting dynamic, 20: 617 (AD-611540)
BLOOD
albumin content of, effects on cells of blood and other tissues, 20: 61(R) (NYO-901-37, pp 69-73)
extracorporeal irradiation of human, use in studying leukemia and lymphopoiesis, 20: 1 (BNL-9363)
hemodynamic studies on patients with Chagas disease, 20: 163(R) (STI/DOC/10/42, pp 71-127)
iron-55 content in human, 20: 153(R) (NYO-3086-1 Pt.X)
radiation effects on lipid content in, of rabbits, 20: 77
radiodiagnosis of diseases of, use of chromium-51 and iron-59 for, 20: 207
radiotherapy of diseases of, radiation hazards during pregnancy, 20: 199
BLOOD CELLS
desoxyribonucleic acid metabolism in human, during leukemia, tracer study, 20: 20 (EUR-2451.e)
physiology of, 20: 61(R) (NYO-901-37, pp 69-73)
radioinduced chromosome aberrations of human, in tissue culture, 20: 60(R) (NYO-901-37, pp 33-68)
BLOOD FORMATION
DNA labeling in human granulocyte, review, 20: 1 (BNL-9363)
BLOOD PICTURE
radiation effects in rats, effects of leukocyte-stimulating drugs on, 20: 194
use for diagnosing radiation injuries, 20: 116
use for diagnosis of radiation injuries of man, 20: 64 (SZS-5(1965))
BLOOD PLASMA
metabolism of bismuth-212, lead-212, and radium-224 from thorium-228 decay in beagle, 20: 42
BLOOD PLATELETS
radiation effects on metabolism in, of chickens, 20: 76
BLOOD PRESSURE
hypertension-induction in rat, effects of genetic background on, 20: 1558 (BNL-9404)
BLOOD SERUM
analysis for cobalt-57-vitamin B_{12}, radiometric, 20: 28
radiation effects on propylhydroperoxide reduction by rat, 20: 54
radiation effects on sulfhydryl content of rat, uv, 20: 93
radiation effects from internally deposited radioisotopes on lactic dehydrogenase levels in beagle, 20: 112
BLOOD VESSELS
ligation in rats, tumorigenic effects of, 20: 10 (TID-21261)
BODEGA BAY POWER REACTOR
fission product inventory after maximum credible operating accident, calculations, 20: 575 (CONF-650407, pp 753-75)
BOILERS
design of, using primary reactor cooling fluid as heating fluid, 20: 1517(P)
BOILING
bubble dynamics in, (T), 20: 489
nucleate, effects of nonuniform heat flux on departure from, 20: 492
nucleate, of subcooled fluid, temperature distribution in, (T), 20: 485(T) (ANL-Trans-225)
BOILING REACTORS
accident analysis in, program for evaluation of data for blowdown, 20: 570 (CONF-650407, pp 609-40)
design and performance of, for power production, 20: 1484
design development for CIRENE, 20: 1489
design of heterogeneous, for insertion into bituminous deposits in bore holes, 20: 1526(P)
design of Russian, 20: 1351 (WASH-1060)
design of superheating, 20: 1522(P)
design of 600-Mw(e) high power density, 20: 1465(R) (GEAP-4894)
design of, for power production, 20: 1486
design of, with coolant nonreturn values in the pressure vessel, 20: 1433(P)
design of, with thin-walled reactor vessel, 20: 1432(P)
fuel element failure in, gamma-spectrometric evaluation of, 20: 853
iodine-131 release from double containment in 750-Mw(t), calculations, 20: 584 (CONF-650407, pp 984-99)
safety evaluation of, performance of models for, 20: 1455 (AWRE-R-3/65)
BONE FRACTURES
remodeling after, calcium-47 uptake in, 20: 8(R) (STI/DOC/10/42, pp 23-43)
BONE MARROW
effects on radiation sickness, therapeutic, 20: 8(R) (STI/DOC/10/42, pp 23-43)
mitotic index in rat, effects of AET on, 20: 143
preservation for human techniques for, 20: 135
preservation of, 20: 134
protective effects of grafts of, against radiation injuries, 20: 134
protective effects of grafts of, against lethal radiation effects in mice, 20: 138
radiation dose from chest radiography, 20: 180
radiosensitivity effects in mice, effects of storage on gamma, 20: 133
radiosensitivity effects in man, effects of preservation technique on, 20: 135
radiosensitivity of cells of adult, 20: 96
BONE TUMORS
calcium metabolism in, use of calcium-47 in study of, 20: 8(R) (STI/DOC/10/42, pp 23-43)
radiodiagnosis using calcium-47, 20: 8(R) (STI/DOC/10/42, pp 23-43)
radioinduced orbital, following retinoblastoma therapy, 20: 168
radioinduced, by deposited plutonium-239, 20: 60(R) (NYO-901-37, pp 33-68)
BONES
calcium metabolism in, isotope studies of, 20: 8(R) (STI/DOC/10/42, pp 23-43)
crystal structure of, effects of strontium on, 20: 232(R) (NYO-901-37, pp 80-4)
lead-210 content and distribution in human, 20: 22(R) (NYO-3086-1 Pt.II)
metabolism in, of lactating rats, 20: 35
radiation dose to rat, natural background, 20: 151(R) (NYO-3086-1 Pt.VII)
radiation effects on growth of jaws in kittens, 20: 91
radium-226 content and distribution in human, 20: 22(R) (NYO-3086-1 Pt.II)
radium-226 content and distribution in dog, following injection, 20: 23(R) (NYO-3086-1 Pt.III)
radium-226 content in human, 20: 603
radium-228 content and distribution in human, 20: 22(R) (NYO-3086-1 Pt.II)
strontium-85 content in human, following intravenous injection, 20: 32
thorium-228 content and distribution in human, 20: 22(R) (NYO-3086-1 Pt.II)

thorium-228 content and distribution in dog, following injection, 20: 23(R) (NYO-3086-1 Pt.III)
BORIC ACID
boric acid–H_2O, corrosive effects on aluminum, 20: 1467(R) (IDO-28649)
BORON
determination in reactor materials, mass spectrometric, 20: 235 (Y-KG-28)
determination in reactor waters, spectrochemical, 20: 256
effects on irradiation embrittlement of type 304 stainless steel, 20: 898
BORON CARBIDES
compatibility with potassium–sodium alloy at 1000°F, 20: 776 (TIM-822)
reactions with stainless steel in potassium–sodium alloy at 1000°F, 20: 776 (TIM-822)
thermal properties to melting point, 20: 878
BORON HYDRIDES
reactions with heavy water, isotope effects in, 20: 306
BORON ISOTOPES B-10
energy levels, (E), 20: 1194
BORON ISOTOPES B-11
excitation in meson (π^-) absorption by carbon-12 at rest, (T), 20: 1193
BORON OXIDES
B_2O_3–WO_3, phase studies on, 20: 847
BOSONS
production of $W^{\pm}$, in electron-positron interactions, (T), 20: 1018
BRAIN
radiation effects on mouse, histopathological gamma, 20: 105
radiation effects on carbohydrate and protein metabolism in, gamma and neutron, 20: 115
radiation injuries of rat, pathology of, 20: 68
BRAIN TUMORS
radiodiagnosis of, use of mercury-203-chlormerodrin as tracer for, 20: 179
BRASS
decontamination from plutonium and fission products, ultrasonic, 20: 430 (CEA-R-2823)
sorptive properties for fission-product iodine from various environments, 20: 574 (CONF-650407, pp 730-46)
BRAZIL
radium-226 and -228 content in food, teeth, and water in, 20: 150(R) (NYO-3086-1 Pt.VI)
BRAZIL (MINAS GERAIS)
radiation dose to rats in, natural background, 20: 151(R) (NYO-3086-1 Pt.VII)
BREEDER REACTORS
design of Russian fast, 20: 1351 (WASH-1060)
BREMSSTRAHLUNG
measurement of, pulse pile-up rejection system for spectral distributions in, 20: 651 (EGG-1183-2055)
production in electron reactions with gold–tungsten alloys, spectral distributions from, (E), 20: 651 (EGG-1183-2055)
production in electron reactions with Apollo spacecraft wall sections, dose rates and spectra from, 20: 1306 (NASA-TM-X-1140)
production of, polarization effects in, (T), 20: 996 (NP-15204)
reactions (γ,n) with carbon-12 to 52 Mev, cross sections for, (E), 20: 1196
reactions with helium-4, meson (π^+) production in, (E), 20: 1210
reactions with nuclei, production of manganese-52, scandium-44 and yttrium-87 isomers in, (E/T), 20: 1246
spectra of, resonance widths from, 20: 1023
BRITISH REACTORS
development of AGR concept, 20: 1502
BRITTANY POWER REACTOR (EL-4)
automation of, centralized data processing equipment for, 20: 1478
BROMINE
compatibility with silica glass at 900°C, 20: 1559 (BNL-9573)
renal clearance of, tracer study in dogs, 20: 37
BROMINE ISOTOPES Br-82
beta decay of, gamma spectra in, (E), 20: 1243
reactions of recoil, in neutron-irradiated bromobenzene, 20: 376
BROMINE SYSTEMS
Br–Pb–$PbBr_2$, compatibility with silica glass at 900°C, 20: 1559 (BNL-9573)
BROOKHAVEN ALTERNATING-GRADIENT SYNCHROTRON
beam injector for, design and development of 500-Mev, 20: 928 (BNL-9500)
beam intensity of, phase I of conversion program for increasing, 20: 928 (BNL-9500)
magnet design parameters for, (T), 20: 930 (BNL-9553)
magnet power supply modifications for, 20: 928 (BNL-9500)
shielding design criteria for beam intensity increase, 20: 928 (BNL-9500)
BROOKHAVEN BEAM RESEARCH REACTOR
neutron spectrometer for, engineering drawings for, 20: 672
BROOKHAVEN SYNCHROTRON
magnetic field measurement of, 20: 932 (BNL-9557)
BUBBLE CHAMBERS
development for high-energy particles, 20: 649 (BNL-9543)
kinetics in boiling, (T), 20: 489
kinetics in liquids, equations of motion and boundary conditions for, (T), 20: 487
BUCKBOARD MESA QUADRANGLE (NEV.)
geologic studies of Pre-Schooner sites in basalt, preshot, 20: 511 (PNE-505P)
BUILDING MATERIALS
book: *The Architect in the Nuclear Age*, 20: 1577
properties and use for space vehicles, conference on, 20: 877
BULGARIA
radiation protection regulations for laboratories in, 20: 602(T) (JPRS-31747)
BUTADIENE
radioinduced graft polymerization with cotton and rayon, properties of product in, 20: 363
acrylonitrile–butadiene, radioinduced graft polymerization with cotton or rayon, 20: 363
butadiene–styrene, radioinduced graft polymerization with cotton or rayon, 20: 363
1,3-BUTADIENE, 2-METHYL- POLYMERS
radiation effects on isomerization of, in benzene solution and in solid state, 20: 364
BUTADIENE POLYMERS
radiation effects on thermoluminescence of mixtures of, 20: 366
BUTANE, 2,2,3-TRICHLOROHEPTAFLUORO-
degradation of C-437 by fluorine, 20: 346 (GAT-L-420)
1-BUTANOL
reactions with anhydrous praseodymium and neodymium chlorides to form alcoholates, 20: 316
BUTYL PHOSPHATE COMPLEXES
with metals in TTA, synergism in, 20: 261
BUTYL PHOSPHATES
spectra of uranium nitrates and perchlorates in, 20: 321
BUTYRIC ACID, 2-AMINO-4-MERCAPTO-, THIOLACTONE
radiation effects on, ESR spectra of uv and x-ray, 20: 386

C

CADAVERS
radioactive, procedures for post-mortem examinations, 20: 58(R) (NYO-901-37, pp 14-30)
CADMIUM
effects in rat testes, tumorigenic, 20: 10 (TID-21261)
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
electron plasma resonances in, analysis using photon scattering, (T), 20: 1326 (ORNL-P-1600)
preparation for isotopic targets, 20: 696(R) (ORNL-3829)
separation from uranium by extraction chromatography, 20: 433 (INP-412/C)
CADMIUM ALLOYS
Cd–Mg–Zn, solvent properties of melts of, for plutonium and uranium, 20: 447
CADMIUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
CADMIUM ISOTOPES Cd-114
energy level structure, (E), 20: 1173
proton inelastic scattering by, conversion electron spectra from, (E), 20: 1173
CADMIUM ISOTOPES Cd-115
distribution from nuclear excavation in basalt, 20: 613
CALCIUM
absorption in humans with bone diseases, gastrointestinal, 20: 8(R) (STI/DOC/10/42, pp 23-43)
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
metabolism in bone tumors, 20: 8(R) (STI/DOC/10/42, pp 23-43)
metabolism in human rickets, 20: 8(R) (STI/DOC/10/42, pp 23-43)
metabolism in man following intravenous injection of strontium-85, 20: 32
uptake during remodeling of fractured bone, 20: 8(R) (STI/DOC/10/42, pp 23-43)
CALCIUM CHLORIDES
effects on radioinduced changes in proteins, 20: 49
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
protective effects of, against radiation injuries in mussels, 20: 139
CALCIUM FLUORIDES
CaF_2–U, diffusion of argon and xenon from monocrystals of, 20: 1324(R) (EURAEC-1428)

CALCIUM HYDROXIDES
bond energy of CaOH, 20: 294(T) (UCRL-Trans-1239(L))
CALCIUM IODIDES
gamma total absorption in europium-doped, 20: 676
CALCIUM IONS
exchange on phosphonate resin Bio-Rex 63, kinetics of, 20: 263
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
CALCIUM ISOTOPES Ca-40
proton elastic scattering by, optical model parameters for distributions and polarizations from, (E/T), 20: 1157 (ORNL-P-1616)
proton inelastic scattering at 156 Mev, excitation of octupole and quadrupole levels in, (T), 20: 1215
CALCIUM ISOTOPES Ca-44
proton reactions (p,n) at 370 Mev, nuclear-structure effects in, (E/T), 20: 1213
CALCIUM ISOTOPES Ca-45
beta decay of, branching in, (E), 20: 1206
detection and measurement of, by 4π gas counter, 20: 666
determination by autoradiography using ring-oven method, temperature effects on fading effect in, 20: 251
excretion by kidneys of dogs, 20: 30
use in studies of bone growth, 20: 8(R) (STI/DOC/10/42, pp 23-43)
CALCIUM ISOTOPES Ca-47
use in studies of calcium metabolism in bones, 20: 8 (STI/DOC/10/42, pp 23-43)
CALCIUM ISOTOPES Ca-48
proton reactions (p,n) at 370 Mev, nuclear-structure effects in, (E/T), 20: 1213
CALCIUM NITRATES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
CALCIUM OXIDES
diffusion of argon from crystals of, 20: 1324(R) (EURAEC-1428)
effects on grain boundary hardening in sintered beryllium oxide, 20: 846
effects on stabilization of zirconia, effects of aluminum, iron, silicon, and titanium oxides on, 20: 867
$CaO–Sc_2O_3$, phase diagram, 20: 841
$CaO–ZrO_2$, preparation of dense and homogeneous samples by melting techniques, 20: 798
CALCIUM SULFIDES
CaS–rare earth sulfides, crystal structure of solid solutions in, 20: 332
CALDER HALL REACTORS
commissioning procedures for Dungeness A and B, 20: 1505
core performance in Dungeness B, (T), 20: 1498
design of Dungeness B, evolution of, 20: 1500
design of Dungeness B, appraisal of, 20: 1501
development of Dungeness A, engineering problems in, 20: 1504
development of Dungeness A and B, 20: 1506
electric system of, design review, 20: 1507
fuel elements for Dungeness B, design and development of, 20: 1499
performance of, review of, 20: 1482
CALORIMETERS
calibration of gamma, 20: 1466(R) (HPR-63)
design of twin isothermal, for plutonium determination, 20: 259
performance for thermal flux rate measurement, comparison with other sensors, 20: 624 (SC-DC-65-1507)
CALUTRONS
plasma properties in, (E), 20: 1272(R) (ORNL-3836, pp 36-66)
CAMBRIDGE SYNCHROTRON
beam interactions with laser beam, monochromatic gamma beam production in, (E/T), 20: 936 (SLAC-41)
experimental facilities development for, 20: 991(R) (CEAL-1023)
CANADA
fallout monitoring, 1965, 20: 596 (NP-15542)
fallout monitoring, 1965, 20: 597 (NP-15563)
nuclear power in, future prospects of, 20: 1454 (AECL-2293)
CANADIAN REACTORS
environs monitoring, 1965, 20: 596 (NP-15542)
environs monitoring, 1965, 20: 597 (NP-15563)
CANDU REACTOR
electric system of, design review, 20: 1507
CAPE THOMPSON–CAPE SEPPINGS AREA (ALASKA)
radionuclide contents in tundra in Ogotoruk Valley, 20: 525
CARBOHYDRATES
radiation effects on metabolism in brain, gamma and neutron, 20: 115
CARBON
determination in uranium, effects of nitric acid etching on, 20: 230 (NLCO-965, pp 4.1-5)
effects of impurity atoms of, combined with neutron irradiation on structure of molybdenum, 20: 895
effects on fast neutron radioinduced swelling in molybdenum, 20: 745(R) (BNWL-120, pp 3.1-22)
hardness of coatings of pyrolytic on uranium carbide, 20: 797
neutron inelastic scattering at 14.6 Mev, angular distributions, cross sections, and energy levels in, 20: 1144 (AD-614451)
proton energy losses in thin foils of, (E), 20: 969
proton total cross sections at 16.4 Mev, (E), 20: 1208
reactions of recoil, with organic compounds, 20: 359
reactions with uranium dioxide in nitrogen, calculation of equilibrium yields of uranium nitrides in, 20: 288 (ORNL-TM-1264)
solubility in plutonium at 700 to 950°C, 20: 1534(R) (LA-3370)
use in electron transmission window, 20: 509(P)
vapor pressure, 20: 331
yields from thermal decomposition of lanthanum and thorium oxalates, 20: 317
CARBON (ACTIVATED)
radioactive contamination in Japan, effects of weapons testing on, 1959 to 1962, 20: 534
CARBON DIOXIDES
analysis for oxygen-18, mass spectrometric, 20: 243
corrosive effects on graphite at 940 to 1740°F, 20: 1534(R) (LA-3370)
corrosive effects on graphite, 20: 756
inhalation studies using carbon-14, design of exposure chamber for, 20: 58(R) (NYO-901-37, pp 14-30)
radioinduced decomposition on oxide semiconductors, products in, 20: 413
yields from thermal decomposition of lanthanum and thorium oxalates, 20: 317
CARBON ISOTOPES C-12
bremsstrahlung reactions (γ,n) to 52 Mev, cross sections for, (E), 20: 1196
deuteron reactions (d,α) at 24 Mev, energy spectra from, (E), 20: 1211
deuteron reactions (d,p) at 2 to 3 Mev, gamma-proton angular correlations in, (E), 20: 1242
helium-3 elastic scattering at 29 Mev, polarization in, (T), 20: 1171
meson (μ^-) capture reactions with, elementary-particle model for, 20: 1207
meson (π^-) absorption at rest, (T), 20: 1193
proton elastic scattering by, optical model parameters for distributions and polarizations from, (E/T), 20: 1157 (ORNL-P-1616)
proton inelastic scattering at 156 Mev, excitation of octupole and quadrupole levels in, (T), 20: 1215
CARBON ISOTOPES C-13
alpha reactions (α,α) and (α,n) at 2 to 3.5 Mev, cross sections for, (E), 20: 1212
spectra of, developments in NMR, 20: 330
CARBON ISOTOPES C-14
determination in biological materials by oxidation and liquid scintillation counting, 20: 253
effects of thymidine labeled with, carcinogenic, 20: 66 (TID-22292)
effects on benzophenone-benzhydrol equilibrium, 20: 347(R) (TID-22251)
effects on decomposition of *p*-nitrophenethyltrimethylammonium iodide, 20: 347(R) (TID-22251)
incorporation in 6-azacholesterol, 20: 345 (EUR-2450.d)
CARBON MONOXIDES
bismuth-212 and lead-212 transport in carrier gases of, 20: 427
yields from thermal decomposition of lanthanum and thorium oxalates, 20: 317
CARBON STEEL
fatigue strength of pipes of, weld crack effects on, 20: 759
sorptive properties for fission-product iodine from various environments, 20: 574 (CONF-650407, pp 730-46)
CARBON SYSTEMS
Al–C–Fe–Si–U, radioinduced swelling in, effects of pressure on reactor, 20: 745(R) (BNWL-120, pp 3.1-22)
C–Hf–Ni, phase studies of nickel-rich, 20: 826 (NP-15535)
C–Hf–Ta–W, cavitation damage of T-222 in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
C–Hf–Ta–W, erosion by sodium at 400, 1000, and 1500°F of T-222, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–Ta–W–Zr, erosion by sodium at 400, 1000, and 1500°F of Cb-132M, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–W–Zr, thermal properties to melting point, 20: 878
C–Mo–W–Zr, thermal properties to melting point, 20: 878
C–Nb–W–Y–Zr, corrosion by potassium at 2000°F of AS-55, 20: 768(R) (NASA-CR-54226)
C–Nb–W–Zr, corrosion by potassium at 2000°F of D-43, 20: 768(R) (NASA-CR-54226)
C–Nb–Zr, thermal properties to melting point, 20: 878
C–Ni–Zr, phase studies of nickel-rich, 20: 826 (NP-15535)
CARBON TETRACHLORIDE
CCl_4–dibutyl butyl phosphonate, use in separation of americium from waste, 20: 436 (RL-SEP-518)
CARBON TETRAFLUORIDE
effects on radioinduced polymerization of isobutylene, 20: 409
CARBONATES
age estimation of, in Lake Bonneville and Lake Lahontan, Great Basin,

20: 546
CARCINOGENS
effects of benzanthracene as, in female rats, 20: 60(R) (NYO-901-37, pp 33-68)
CARCINOMAS
effects on response of laryngeal mucosa to x radiation, 20: 166(T) (N64-20943, pp 1–8)
etiology and pathology of bladder, 20: 60(R) (NYO-901-37, pp 33-68)
metastasis of cervical, 20: 60(R) (NYO-901-37, pp 33-68)
radioinduced thyroid, incidence of, 20: 203
radiotherapy of bronchial, pulmonary ventilation following, x, 20: 159
radiotherapy of cervical, in pregnant women, 20: 201
radiotherapy of lung, late pathological effects on spinal cord, 20: 100
radiotherapy of uterine, late pathological effects on intestine, 20: 186
radiotherapy of uterine, effects on rectum, 20: 193
radiotherapy of uterine, late pathological effects on intestine, 20: 210
radiotherapy of uterine, effects on lymph node metastases, 20: 212
radiotherapy of, development of sarcomas after, 20: 211
radiotherapy of, evaluation of high-energy electron, 20: 205
radiotherapy of, late leukemia after, 20: 94
CARDIOGRAPHY
of radiation effects on heart function, 20: 213
CAROLINAS-VIRGINIA TUBE REACTOR
operation, Aug. 1965, 20: 1462(T) (CVNA-243)
radioactivity release from, atmospheric diffusion map overlays for, 20: 561 (CONF-650407, pp 439-54)
CASCADE IMPACTORS
use to measure size distribution of airborne heavy particles, 20: 588 (CONF-650407, pp 1162-1203)
CASCADE SHOWERS
production in accelerator shielding materials, 20: 935 (ORNL-TM-1298)
theory of, invariant imbedding techniques in, 20: 1062
CASCADES
transformation theory for separation, (T), 20: 448
CASTLE OPERATION
fallout, effects in Marshallese population ten years post-exposure, 20: 90
CATALYSTS
preparation of inorganic oxide, for use in exhausts of internal combustion engines, 20: 343(P)
CATARACTS
surgery of, unfavorable tissue reactions to radiosterilized sutures, 20: 712
CATS
radiation effects in, biological, 20: 43
radiation effects on growth of jaws in kittens, 20: 91
toxicity of nitrogen mustards in, 20: 43
CATTLE
iodine-131 content in milk from, effects of dietary factors and content on pasture, 20: 598 (NP-15568)
CAVES
fuel tube examination in, engineering drawings of profilometer for, 20: 494
CAVITATION
damage to alloys in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
CELLULOSE
radioinduced crosslinking of fabrics of regenerated, with N-methylol compounds, 20: 358(T) (NP-tr-1299)
CENTRIFUGAL PUMPS
cavitation performance of, dimensional analysis, 20: 460 (ORNL-P-1447)
CENTRIFUGATION
sterilization techniques for virus isolation by zonal, 20: 7(R) (ORNL-3883)
techniques for respiratory syncytial viruses, 20: 7(R) (ORNL-3883)
zonal, use for isolating adenovirus antigens, 20: 7(R) (ORNL-3883)
CERAMIC BODIES
strengthening by surface compression, 20: 817 (CONF-710)
CERAMIC MATERIALS
conference on high-strength, 20: 817 (CONF-710)
preparation from irradiated fuel swarf, for long-term storage, 20: 1554
CERIUM
determination in magnesium alloys by potentiometric titration using vanadium(II) salts, 20: 274
determination of, in rare-earth mixtures, photometric, 20: 252
electric conductivity of, effects of phase transformations on, 20: 829 (TID-2225)
electric conductivity at low temperatures, effects of dilute rare earth additions on, 20: 864
optical reflectivity of, temperature dependence of, (E), 20: 917 (TID-22277)
separation from low-level waste water, 20: 1549 (ORNL-3811)
sorption by soil colloids, 20: 19
uptake by plants, 20: 19
CERIUM ALLOYS
Ce–Co–Pu, reactions with tantalum at high temperatures, 20: 1534(R) (LA-3370)
Ce–Co–Pu, segregation by solidification, effects on reactivity of, 20: 1534(R) (LA-3370)
Ce–Co–Pu, diffusion through fuel can fission-gas vents, mechanisms of, 20: 1534(R) (LA-3370)
Ce–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Sb–Ce, magnetic properties, 20: 309
CERIUM ARSENIDES
magnetic properties, 20: 309
CERIUM CHLORIDES
stability and ion pairing, 20: 299
CERIUM FLUORIDES
metabolism in lungs, after intratracheal administration to rabbits, tracer study, 20: 38
CERIUM IONS
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
CERIUM ISOTOPES Ce-137
nuclear orientation in cerium magnesium nitrates, temperature scale from, 20: 1338
CERIUM ISOTOPES Ce-141
distribution from nuclear excavation in basalt, 20: 613
CERIUM ISOTOPES Ce-144
content in plants of Alaska, 1959 to 1962, 20: 525
decay of, contribution to total beta activity of coastal sediments of Ligurian Sea from, 20: 526
distribution from nuclear excavation in basalt, 20: 613
metabolism in rat bone, autoradiographic study, 20: 34
separation from praseodymium-144, solvent extraction, 20: 444
CERIUM NIOBATES
preparation and structure of perovskite type, 20: 844
CERIUM NITRIDES
electric conductivity and magnetic susceptibility at low temperatures, (E), 20: 1332
CERIUM OXIDES
CeO_2–BaO, phase studies, 20: 302
CERIUM PHOSPHIDES
magnetic properties, 20: 309
CERIUM TANTALATES
preparation and structure of perovskite type, 20: 844
CESIUM
determination by concentration-dependent distribution method, 20: 250
electric discharge in, properties of hollow-cathode, (E), 20: 1087
electron density of weakly ionized plasma of, (E), 20: 1282
separation from low-level waste water, 20: 1549 (ORNL-3811)
sorption by soils, review of selective, 20: 1555
CESIUM AMERICYL CARBONATES
preparation and lattice constants, 20: 305
CESIUM CHLORIDES
ion self-diffusion mobilities in, determination from tracer transfer rate coefficients, 20: 425
metabolism in guinea pigs of cesium-137-labeled, 20: 33
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
CESIUM CHROMATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
CESIUM IODIDES
gamma total absorption in thallium-doped, 20: 676
CESIUM IONS
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
CESIUM ISOTOPES Cs-129
beta decay of, gamma spectra and half life in, (E), 20: 1200
CESIUM ISOTOPES Cs-133
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173
CESIUM ISOTOPES Cs-134
beta decay of, circular polarization of gamma rays after, (E), 20: 1240
CESIUM ISOTOPES Cs-136
distribution from nuclear excavation in basalt, 20: 613
CESIUM ISOTOPES Cs-137
content in food from EURATOM countries, 1963, 20: 144 (EUR-2460.d,f,i,s)
content in human diet, 20: 521(R) (HASL-164)
content in milk, 20: 596 (NP-15542)
content in milk, 20: 597 (NP-15563)
content in milk, in Germany, 20: 524
content in natural and processed materials in Australia, 20: 156
content in plants of Alaska, 1959 to 1962, 20: 525
determination in biological materials, radiochemical, 20: 218(R) (STI/DOC/10/42, pp 1-22)
distribution from nuclear excavation in basalt, 20: 613

exchange in cesium chloride solutions, rate coefficients for, 20: 425
half-life in man, 20: 521(R) (HASL-164)
metabolism in guinea pigs of cesium chloride-incorporated, 20: 33
use in sources of mock iodine-131, 20: 416 (NP-15525)
CHARCOAL
sorptive properties of activated, for iodine-131 from air, 20: 278 (CONF-650407, pp 814-29)
sorptive properties of activated, for iodine vapor and methyl iodide from air, 20: 280 (CONF-650407, pp 869-84)
sorptive properties for iodine released in reactor accidents, 20: 578 (CONF-650407, pp 830-52)
use for removal of methyl iodide from gases, 20: 279 (CONF-650407, pp 852-68)
CHARGED PARTICLE BEAMS
deflection in three-sector cyclotrons, computer studies of, 20: 944
focusing in accelerators, device for, 20: 946(T)
focusing of, computer program for magnetic channel design for, 20: 934 (ISS-65/4)
CHARGED PARTICLES
acceleration in standing-wave linacs, normal-mode analysis of, (T), 20: 929 (BNL-9514)
biological effectiveness of, relation of velocity to relative, (T), 20: 98
containment in DCX-1, (E), 20: 1269(R) (ORNL-3836, pp 1-14)
containment in DCX-2, 20: 1270(R) (ORNL-3836, pp 15-32)
dosimetry, role of momentum in, 20: 605
energy losses in thin foils, (E), 20: 969
interactions with periodically inhomogeneous media, Cherenkov radiation from, (T), 20: 979
motion in crossed electric and magnetic fields, (T), 20: 1266 (NP-15450)
CHELATION
effectiveness in removing strontium from body, 20: 8(R) (STI/DOC/10/42, pp 23-43)
CHEMICAL RADIATION DETECTORS
properties and stability of polyacrylamide and polyisobutylene, for gamma and proton activities, 20: 391
properties of alanine for activities to 1.25 Mev, 20: 394
CHEMICALS AND REAGENTS
radiation absorption by, 20: 923
CHEMISTRY
book: *The Chemistry of the Rare Earth Elements*, 20: 219
constants and conversion factors in, review of fundamental, (T), 20: 922
plasma jet uses in, 20: 1277 (TID-22136)
CHEMOTHERAPY
effects on tumors, synergistic effects with radiotherapy, 20: 194
CHERENKOV DETECTORS
development for high-energy particles, 20: 649 (BNL-9543)
CHERENKOV RADIATION
emission by charged particles interacting with periodically inhomogeneous media, (T), 20: 979
CHICAGO
fallout monitoring in, Argonne program for, 20: 521(R) (HASL-164)
radium-228 monitoring in foods at, 20: 148(R) (NYO-3086-1 Pt.IV)
CHICKENS
growth of x-irradiated Rous sarcoma virus on chorioallantoic membrane of embryonic, 20: 103
infection with nematode parasites, *Synagamus trachea*, 20: 70
manganese metabolism in, effects of dietary manganese on, 20: 29
radiation effects on hemoglobin metabolism in, 20: 76
CHIMERAS
radiation, hematopoietic function in, 20: 104
CHINON REACTORS
electric system of, design review, 20: 1507
CHINON REACTORS (EDF-1)
pressure vessel design for, 20: 1479
CHLORIDES
radiation effects on aqueous solutions of, yields from, 20: 360
renal clearance of, tracer study in dogs, 20: 37
CHLORINE
effects on corrosion of iron by terphenyl, 20: 777
Joshi effect in, light intensity and frequency inversion of, 20: 920
radioinduced formation of, in aqueous chloride solutions, 20: 360
reactions with uranium tetrachloride in fused salt, kinetic studies, 20: 292 (UCRL-16173)
use in plutonium–uranium separation, 20: 456(P)
CHLORINE FLUORIDES
use in fluorination of plutonium and uranium fuels, 20: 432(R) (EURAEC-1402)
CHLORINE ISOTOPES Cl-35
nuclear properties, (E), 20: 1146 (COO-1120-38)
CHLORITES
reactions with peroxymonosulfuric acid in solution, kinetics, 20: 1571(R) (TID-22186)
CHLOROÖRGANIC COMPOUNDS
sorption on clays, 20: 777
CHOLESTEROL
metabolism of, 20: 61(R) (NYO-901-37, pp 69-73)
CHOLESTEROL, 6-AZA-
synthesis of carbon-14-labeled, 20: 345 (EUR-2450.d)
CHOLINE CHLORIDE
crystal structure, x-ray diffraction study of, 20: 232(R) (NYO-901-37, pp 80-4)
radiolysis of crystalline, radical termination mechanisms in electron and gamma, 20: 378
CHROMIUM
content in teeth after use in dental restorations, 20: 27
determination as corrosion product in fuel solution of Berlin Research Reactor, 20: 1541
diffusion in chromium–nickel alloys, 20: 834(T) (AERE-Trans-1031)
electron density of states of, effect of antiferromagnetic transition on, (E), 20: 1330
thermal capacity of, magnetic hyperfine, 20: 832 (UCRL-16180)
vapor pressure, 20: 331
vapor pressure, 20: 834(T) (AERE-Trans-1031)
CHROMIUM ALLOYS
electron density of states of, effect of antiferromagnetic transition on, (E), 20: 1330
Cr–Ni, diffusion of chromium and nickel in, 20: 834(T) (AERE-Trans-1031)
Cr–Ni, thermodynamic properties, 20: 834(T) (AERE-Trans-1031)
Cr–Pd, phase studies at 800 to 1400°C, 20: 338
Cr–Pt, phase studies at 800 to 1400°C, 20: 338
Cr–U, separation of barium-140 and lanthanum-140 from irradiated droplets of, by solvent extraction using molten magnesium, 20: 292 (UCRL-16173)
CHROMIUM CARBONYLS
complexes with cyclic phosphite esters, 20: 1561 (IS-T-31)
CHROMIUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
CHROMIUM ISOTOPES Cr-51
use in diagnosis of blood diseases, 20: 207
CHROMIUM ISOTOPES Cr-54
proton reactions (p,n) at 370 Mev, nuclear-structure effects in, (E/T), 20: 1213
CHROMIUM OXIDES
Cr–Cr_2O_3, reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-4942)
CHROMIUM STEEL
corrosion of Croloy 9M, by liquid potassium–sodium in test loops, 20: 773(R) (ORNL-3859)
decarburization of Croloy 9M, effects on mechanical properties of, 20: 773(R) (ORNL-3859)
CHROMIUM SYSTEMS
Cr–Cr_2O_3, reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
Cr–PuC, analysis of cermets of, for plutonium, 20: 222 (AERE-R-4975)
CHROMOSOMES
aberrations of, in human bone marrow and skin biopsy specimens in cultures, 20: 94
desoxyribonucleic acid metabolism in human leukemic cell, tracer study, 20: 20 (EUR-2451.e)
patterns in man, 20: 94
radioinduced aberrations of, in man, 20: 60(R) (NYO-901-37, pp 33-68)
radioinduced aberrations in mouse, x, 20: 65(R) (TID-22174)
radioinduced aberrations of, in barley, 20: 97
radioinduced breakage of 5-bromodeoxyuridine-labeled, energy dependence of x, 20: 46 (PRNC-40)
radiosensitivity of, in cultures of human leukocytes, effects of cell-cycle on, 20: 88
radiosensitivity of, in *Escherichia coli*, ultraviolet, 20: 127
CIRCUITS
design and performance of pulse pile-up rejection, for scintillation gamma spectrometers, 20: 651 (EGG-1183-2055)
efficiency of amplifying, for scintiscanner devices, 20: 662
radiation effects on resistance of, method for measuring, 20: 694
radiation effects on, 20: 695
thickness measurements on printed, accuracy of beta-backscatter and x-ray emission, 20: 493
CLAYS
desorption of radioiodine from, by air and water, 20: 600 (ORNL-P-1581)
CLOSTRIDIUM
radiation effects on spore production by *C. botulinum*, 20: 700 (AD-621921)
radiation effects on toxin production by *C. botulinum*, 20: 700 (AD-621921)
radiation effects on toxicity of type E, in packaged fish, 20: 707
COAL

performance in power plants, 20: 610
radiation decomposition in bore holes, design of heterogeneous boiling reactor for, 20: 1526(P)
radioactive contamination of, 20: 152(R) (NYO-3086-1 Pt.VIII)
radioisotope uses in industry of, 20: 706
COATINGS
decontamination of protective, from fission products, 20: 573 (CONF-650407, pp 720-9)
radiation effects on fuel-element, 20: 907
COBALT
content in teeth after use in dental restorations, 20: 27
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
iron-57 Mössbauer effect in single crystals of, (E), 20: 1198
separation from low-level waste water, 20: 1549 (ORNL-3811)
separation from nickel by extraction chromatography, 20: 433 (INP-412/C)
vapor pressure, 20: 331
COBALT ALLOYS
erosion by sodium at 400, 1000, and 1500°F of Stellite-6B, 20: 769(R) (NASA-CR-54459)
Al–Co–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Ce–Co–Pu, reactions with tantalum at high temperatures, 20: 1534(R) (LA-3370)
Ce–Co–Pu, segregation by solidification, effects on reactivity of, 20: 1534(R) (LA-3370)
Ce–Co–Pu, diffusion through fuel can fission-gas vents, mechanisms of, 20: 1534(R) (LA-3370)
Co–Mn–U, phase diagrams, intermetallic compounds in, 20: 874
Co–Pd, phase studies at 800 to 1400°C, 20: 338
Co–Pt, phase studies at 800 to 1400°C, 20: 338
Co–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
COBALT COMPLEXES
with phosphoörganic compounds in TTA and 2,4-pentanediones, synergism in, 20: 261
COBALT IONS
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
COBALT ISOTOPES Co-57
gamma decay, (E), 20: 1182
use as tracer for vitamin B_{12} metabolism study, 20: 28
COBALT ISOTOPES Co-59
photon reactions at 300 Mev peak, isomer production in, (E/T), 20: 1246
COBALT ISOTOPES Co-60
content and distribution in suspended matter in seaweed, 20: 612
detection and measurement of, by 4π gas counter, 20: 666
dose distributions in teletherapy, computer equipment for plotting and reading, 20: 208
effects of implanted pellets of, biological, 20: 58(R) (NYO-901-37, pp 14-30)
transport vessels for, 20: 160
use in dermatological therapy, applicator design for, 20: 177
use in diagnosis, 20: 207
COBALT OXIDES
Co_3O_4–Fe_3O_4, phase studies at 800 to 1400°C, 20: 338
CoO–MgO, phase studies at 800 to 1400°C, 20: 338
Co_3O_4–Mn_3O_4, phase studies at 800 to 1400°C, 20: 338
CoO–MnO, phase studies at 800 to 1400°C, 20: 338
COBALT SYSTEMS
Co–WC, aging mechanism of sintered and annealed, 20: 859
Co–WC, extrusion of, development of techniques for, 20: 796
Co–WC, torsion fatigue strength at –200 to 600°C, 20: 875
COLLAGEN
radiation effects on soluble, uv, 20: 48
radiation effects on synthesis of, by subcutaneous granulomas in rats, 20: 52
COLLOIDS
uptake of cerium, iron, and manganese, by soil, 20: 19
COLUMBIA RIVER
zinc-65 content of oysters near mouth of, 20: 553 (BNWL-SA-293)
COMMUNICATION SYSTEMS
use of distributed-carrier multiplex, for control of CERN accelerators, 20: 933 (CERN-65-28)
COMPTON EFFECT
use for production of monochromatic gamma beams, 20: 936 (SLAC-41)
COMPUTER PROGRAMS
ARGOSY, for design calculation of graphite reactors, 20: 1356
ARGUS and CYCLOPS, for heat transfer in fuel meltdown, 20: 1542
Ax-TNT, performance for reactor accident shock wave calculations, 20: 1350 (TIM-950)
CEP, for neutron first-flight escape from finite cylinders, in MAP for IBM 7040, 20: 1133 (IDO-17075)
CERL-II, for stress distributions in hemispherical pressure vessel with single radially attached nozzle, FORTRAN IV for IBM 7090, 20: 459 (ORNL-3817)
CROSS PLOT, for plotting neutron differential cross section data, for IBM 7044, 20: 1149 (GAMD-6507)
FLAME, for reactor depletion analysis, 20: 1421 (AD-611775)
FLEX-II, for reactor physics analyses, 20: 1515
for HBWR analysis, development of, 20: 1466(R) (HPR-63)
for reactor fuel bundle sheath temperatures, for G-20, 20: 480 (AECL-2269)
for stress analysis of rotating disks, 20: 467
FREAK, for frequency distribution tables, in APEX for CDC G-20, 20: 733 (CRT-1167)
NUBE, for evaluating hazards of different reactor accidents, 20: 587 (CONF-650407, pp 1080-90)
OPTIK 2, for magnetic channel design, for IBM 7040, 20: 934 (ISS-65/4)
REM, for metallurgical test data, 20: 889(R) (BNWL-120, pp 4.1-59)
RSAC, for radiological safety analysis of reactors, for IBM 7040, 20: 1348 (CONF-650407, pp 1057-70)
Seal-Shell-2, for stresses in cylinder-to-sphere connections, 20: 457(R) (BMI-X-276)
TRIM, for analysis of magnet fields, (E), 20: 940 (UCRL-16382)
COMPUTERS
development of on-line, for Big Rock Point reactor, 20: 1465(R) (GEAP-4894)
development of system using remote consoles, Harwell specification of, 20: 731 (AERE-M-1627)
equipment for plotting and reading isodose distributions in cobalt-60 teletherapy, 20: 208
research, 20: 732(R) (COO-614-37)
use for dose calculations for radiotherapy, 20: 167(T) (N64-20943, pp 35-46)
use of IBM 704, in data processing in aerial surveys of terrestrial radiation, 20: 520 (CEX-59.4(Pt.3))
uses for automation of Brittany Power Reactor (EL-4), 20: 1478
uses in automation of Osiris Reactor at Saclay, 20: 1536
CONCRETES
gamma and neutron scattering in underground structures of, methods for calculating, (E/T), 20: 1307 (RRA-M45)
gamma and neutron scattering in underground structures of, calculations for, (E/T), 20: 1308 (RRA-T41)
gamma and neutron scattering in underground structures of, methods for calculating, (E/T), 20: 1310 (RRA-T51)
gamma backscattering at 0.6 to 7 Mev, tabulations for, 20: 1309 (RRA-T46)
gamma dose buildup factors for, (T), 20: 1311 (RT/PIMA(65)2)
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
neutron fluxes and spectra in reactor shielding of, fast, (E/T), 20: 1318
properties as reactor material, 20: 1312
properties as shielding material for reactor environmental test chambers, 20: 478
use of prestressed, in pressure vessel construction, 20: 1358
CONFERENCES
see also introduction to Report Number Index
Accelerator Symposium, Proceedings of Third Nordic-Dutch, Hanko, Aug. 16–23, 1964, 20: 943
AEA Convention on Civil Liability for Nuclear Damage, scope and status of, 20: 609
AEC Air-cleaning, Oak Ridge National Lab., Tenn., Oct. 22 to 25, 1963, 20: 518
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on use of isotopes and radiation in soil-plant studies, Ankara, June 28–July 2, 1965, 20: 632
on use of isotopes and radiation in soil-plant nutrition studies, Ankara, July 28–June 2, 1965, 20: 633
on use of isotopes and radiation in soil-plant nutrition, Ankara, June 28–July 2, 1965, 20: 699
Peaceful Uses of Atomic Energy, Tashkent Conference on, Vol. III, USSR, 1959, 20: 11(T) (AEC-tr-6293)
Plasma Effects in Solids, First Symposium on, Paris, July 16 and 17, 1964, 20: 1346
Semiconductors, Seventh International Conference on Physics of, Paris, July 19–24, 1964, 20: 1345
CONNECTICUT YANKEE POWER REACTOR
design and development, July 1964–June 1965, 20: 1476(R) (TID-22288)
CONSTANTS AND CONVERSION FACTORS
tables of chemical and physical, 20: 922
CONSTITUTION DIAGRAMS

prediction of multicomponent transition metal, 20: 882
CONVECTION
in model atmosphere, 20: 517 (UCRL-12415-T)
CONVERSION ELECTRONS
spectra from proton reactions (p,2n) with vibrational nuclei, (E), 20: 1173
COPPER
decontamination from plutonium and fission products, ultrasonic, 20: 430 (CEA-R-2823)
determination in biomaterials by neutron activation methods, 20: 254
diffusion on tungsten, field-emission microscopy of adsorption and surface, 20: 849
electron reactions with single crystals of, orientation effects on K x-ray emission in, (E), 20: 1331
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
isomer shift as function of pressure, Mössbauer effect for, (E), 20: 1344
mechanical properties of composites of tungsten fibers in matrix of, 20: 884
properties of, research program on, 20: 1562(R) (NYO-2684-39)
proton total cross sections at 16.4 Mev, (E), 20: 1208
radiation effects on dislocation in, at low temperatures, 20: 897
radiation effects on, electron microscopy of defects from neutron, 20: 906
radiography of, scattering in fast neutron, 20: 667
radioinduced defects in, stage III annealing of proton, 20: 902
separation from nickel by extraction chromatography, 20: 433 (INP-412/C)
sorptive properties for fission-product iodine from various environments, 20: 574 (CONF-650407, pp 730-46)
sorptive properties of annealed and oxidized single crystals of, for undecanoic and nonadecanoic acids, 20: 1570 (TID-22150)
superconductivity in films of, on superconducting indium–lead alloys in magnetic fields, (E), 20: 1124
vaporization of, under vacuum and forced convection conditions, (T), 20: 831 (UCRL-14274)
COPPER ALLOYS
properties of, research program on, 20: 1562(R) (NYO-2684-39)
Cu–Mn, thermal capacity below 1°K, 20: 832 (UCRL-16180)
Cu–Sn, production of needle-like Cu_6Sn_5 crystals in matrix of, 20: 760
Sb–Cu–Sn, Mössbauer effect near melting point, 20: 862
COPPER CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
COPPER COMPLEXES
with phosphoörganic compounds in TTA and 2,4-pentanediones, synergism in, 20: 261
with Schiff bases, spectra of, 20: 289 (TID-21358)
COPPER IONS
exchange on phosphonate resin Bio-Rex 63, kinetics of, 20: 263
COPPER ISOTOPES Cu-63
energy levels from nickel-62 (He-3,d) reactions at 22 Mev, (E), 20: 1216
COPPER ISOTOPES Cu-65
energy levels from nickel-64 (He-3,d) reactions at 22 Mev, (E), 20: 1216
COPPER OXIDES
Al_2O_3–CuO_2–lead borate glass, uses for conversion of irradiated fuel swarf to stable ceramic for long-term storage, 20: 1554
CORROSION FILMS
radioinduced deposition on clad fuel rods, effects on rod profiles, 20: 1465(R) (GEAP-4894)
CORROSION LOOPS
development of potassium, for tests of refractory alloys, 20: 770(R) (NASA-CR-54477)
operation for SNAP-8 materials testing, 20: 773(R) (ORNL-3859)
COSMIC ALPHA PARTICLES
flux of primary, near geomagnetic equator, 20: 986
COSMIC ELECTRONS
flux of primary, for magnetic rigidity above 5 Bv, 20: 983 (COO-818-59)
COSMIC NEUTRINOS
detection underground, experiments on, 20: 987
COSMIC NEUTRONS
flux at 30 to 130 Mev at high altitudes, atmospheric, (E), 20: 988
COSMIC PARTICLES
angular distributions of secondary, in high-energy interactions, (E), 20: 984 (IAE-574)
COSMIC PROTONS
flux of primary, for magnetic rigidity above 5 Bv, 20: 983 (COO-818-59)
COSMIC RADIATION
effects on biological systems, 20: 122
intensity of, data tabulations for July–Dec. 1964, 20: 1108
sources of gamma and x, 20: 985
COSMIC SHOWERS
angular distributions of secondaries from high-energy, (E), 20: 984 (IAE-574)
theory of, invariant imbedding techniques in, 20: 1062
COSMOLOGY
formation of spiral arms in differentially rotating disk galaxy, (T), 20: 953
interactions of scalar gravitational waves with Schwarzschild metric in, 20: 957
stability of uniformly rotating gaseous disk, gravitational, (T), 20: 952
COTTON
radioinduced graft polymerization with acrylonitrile, butadiene, and styrene, properties of products in, 20: 363
COUNTING DEVICES
design for whole-body determinations, 20: 659
Hanford Mobile Whole-body, design and uses, 20: 660
CRITICAL ASSEMBLIES
design and development at Netherlands Reactor Center, 20: 1352(T,R) (JPRS-31526)
design for organic-moderated reactor critical experiments, 20: 1413 (RT/ING(65)4)
operation of UHTREX, 20: 1534(R) (LA-3370)
CRITICALITY STUDIES
criticality data for, handbook on, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
interaction calculations for fissile units and reflectors, (T), 20: 590 (CONF-651103-5)
of fuel particle storage containers, 20: 591 (GAMD-6623)
CRYOGENICS
mechanical properties of metals for, review of, 20: 883
CRYSTAL DETECTORS
design of mica-sandwich, for analysis of high-energy fission, (E), 20: 652 (INR-647/I-A,VI/PH)
CRYSTALS
electron energy level transitions in, (T), 20: 1342
excitation energy migration in molecular, (T), 20: 1325 (NP-15453)
growth of, research on, (E), 20: 287 (ORNL-P-1611)
Mössbauer effect in, average value theorem for recoil, (T), 20: 1162(T) (AD-619487)
CUMENE
tritium exchange with water, 20: 347(R) (TID-22251)
CURIUM
separation by ion exchange, 20: 1352(T,R) (JPRS-31526)
separation from americium by anion exchange, using methanol–nitric acid eluant, 20: 439(T) (ORNL-tr-893)
CYCLOBUTANE
deuterium exchange with, on evaporated metal films, 20: 304
1,3-CYCLOHEXADIENE
radioinduced polymerization at 30 to 50°C, 20: 383
CYCLOHEXANE
radiolysis of vaporous, effects of additives on, 20: 377
CYCLOHEXANE, DECAFLUOROBIS(TRIFLUOROMETHYL)-
degradation of C-816 by fluorine, 20: 346 (GAT-L-420)
CYCLOHEXANE, 1,2-DIMETHYLENE-
radioinduced polymerization at 30 to 50°C, 20: 383
CYCLOHEXENE
effects on radiolysis of cyclohexane vapor at 100°C, mechanism of, 20: 377
CYCLOTRONS
beam deflection in three-sector, computer studies of, 20: 944
beam extraction systems for, 20: 950(P)
design of ion, 20: 945(P)
CYLINDERS
impact effects on, analysis of, 20: 463(R) (SC-DC-65-1634)
joining to spheres, stress magnitude predictions for, 20: 457(R) (BMI-X-276)
neutron resonance escape probability for, computer program for calculating, 20: 1133 (IDO-17075)
radiation transport in, formulation of, (T), 20: 1303 (AD-614250)
stress distribution at normally intersecting, (T), 20: 466
CYSTEINE
cysteine–AET, protective effects against radiation effects in monkeys, 20: 140
CYSTINE
radiation effects on disruption of, in ribonuclease, 20: 51
CZECHOSLOVAKIA
fallout monitoring, 1963, 20: 536
fallout monitoring, 1956 to 1961, 20: 537
fallout monitoring, 1959 through 1963, 20: 522
fallout monitoring, 1958 to 1963, 20: 533
radioisotope research at Institute of Medical Physics, 20: 12

D

DATA RECORDING SYSTEMS
design for electronic processing of aerial surveys of terrestrial radiation, 20: 520 (CEX-59.4(Pt.3))

design of, for use in radiobiology studies, 20: 58(R) (NYO-901-37, pp 14-30)
DATA TABULATIONS
airglow, cosmic ray, geomagnetic, ionospheric, and solar phenomena, July to Dec. 1964, 20: 1108
constants and conversion factors in chemistry and physics, 20: 922
criticality parameters, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
cross sections for neutron reactions (n,2n) with medium and heavy nuclei, (T), 20: 1187
gamma backscattering from concretes at 0.6 to 7 Mev, albedo dose for, 20: 1309 (RRA-T46)
gamma dose buildup factors for concretes, 20: 1311 (RT/PIMA(65)2)
geomagnetic field coordinates, corrected by higher order spherical-harmonic terms, 20: 1104
Hankel functions of imaginary argument, spherical, 20: 735 (NRL-6288)
neutron capture and fission constants for plutonium-239, plutonium-241, uranium-233, and uranium-235, 20: 1164
neutron cross section requests, 20: 1161 (WASH-1057)
DECANE
radioinduced cracking at high pressure and temperature, beta, 20: 355(R) (NYO-2978-42)
DECONTAMINATION
of copper and brass from plutonium and fission products, 20: 430 (CEA-R-2823)
of gaseous reactor coolants, design of plant for, 20: 1397(P)
of low-level radioactive process water, 20: 1549 (ORNL-3811)
of protective coatings from fission products, 20: 573 (CONF-650407, pp 720-9)
DEHYDROGENASES
radiation effects from internally deposited radioisotopes on content of serum lactic, in beagles, 20: 112
DENSITOMETERS
design of radiometric, for *in situ* measurements on deep-sea sediments, 20: 551
design of radiometric, for gases, 20: 643(P)
development of gamma-backscattering, for surface measurements, (E/T), 20: 623 (NP-15529)
DENSITY
measurement in dry soils, using neutron sources, comparison of experimental and theoretical methods for, 20: 632
DEUTERIUM
antineutrino reactions with, cross sections for, 20: 993 (COO-818-70)
concentration by dual temperature exchange reaction between hydrogen and water, apparatus for, 20: 264
concentration by exchange between hydrogen gas and liquid ammonia, 20: 729(P)
content in surface and ground waters of karst region, Turkey, 20: 538
determination in heavy water, gas-chromatographic, 20: 265
determination of ortho- and para-, in hydrogen–deuterium mixtures, 20: 237(T) (NP-tr-1266)
deuteron reactions at 25.3 Mev, proton spectra from, (E), 20: 1172
effects on acid-base equilibrium of amines, nuclear magnetic resonance studies of, 20: 239
effects on anodic oxidation of hydrogen, 20: 418
effects on hydrogen bond stability in DNA, 20: 14(T)
effects on infrared spectra of nitrate ions, 20: 324
effects on solvolysis of substituted bromo- and chlorohydrocarbons in acetone–water and ethanol–water mixtures, 20: 336
effects on solvolysis of exo-bornyl bromide, 20: 352
electric currents in plasma of, (T), 20: 1262 (NASA-CR-309)
exchange between cyclobutane and gaseous, on metal films, 20: 304
exchange equilibration with hydrogen, radiation effects on alumina catalyst used in, 20: 368
exchange reactions with hydrogen-bonded N–H groups in *N*-methylacetamide in aqueous solutions, 20: 354
exchange with hydrogen on molybdenum film, 20: 916(R) (SRIA-425-6)
hydrogen exchange with, in muscle proteins, 20: 349
hydrogen exchange with, in proteins, 20: 419
hyperfine splittings in organic free radicals, ratio to hydrogen, 20: 315
isotope effects on dielectric properties and transition temperatures of sodium selenites, (E), 20: 1333
neutron scattering by, polarization of recoil deuterons from, (T), 20: 997 (ORNL-P-1607)
plasma of, properties in theta-pinch devices, (E), 20: 1255 (ARL-65-171)
sound velocity in liquid, quantum cell model for, 20: 1089
DEUTERIUM SYSTEMS
Ar–D, excited states of solid, 20: 1337
DEUTERONS
angular distributions from nickel-62 and -64 (He-3,d) reactions at 22 Mev, (E), 20: 1216
exchange with protons in radical of irradiated single crystals of aspartic acid, (E), 20: 373
interactions with mesons (K^+) at 2.3 Bev/c, (E), 20: 1009
photodisintegration at high energies, velocity-dependent potential in, (T), 20: 1195
polarization from neutron scattering by deuterium, recoil, (T), 20: 997 (ORNL-P-1607)
production and transverse momentum distributions in proton-proton interactions at 11.6 to 22.9 Bev/c, (E/T), 20: 1031
reactions (d,α) with carbon-12, nitrogen-14, and oxygen-16 at 24-Mev, (E), 20: 1211
reactions (d,α) with light and medium nuclei, distorted-wave model in, (E/T), 20: 1238
reactions (d,n) with beryllium-9 at 2.6 to 7.0 Mev, boron-10 energy levels from, (E), 20: 1194
reactions (d,p) with carbon-12 at 2 to 3 Mev, gamma-proton angular correlations in, (E), 20: 1242
reactions (d,p) with aluminum-27 and silicon-28 at 1.7 to 3.7 Mev, (E), 20: 1244
reactions (d,p) with vanadium-51 at 10.1 Mev, (E/T), 20: 1167
reactions (d,p) with sodium-23 at 1.0 to 2.5 Mev, (E), 20: 1185
reactions with argon, helium, and neon at 12.9 to 21.0 Mev, electron capture in, 20: 974
reactions with deuterium at 25.3 Mev, proton spectra from, (E), 20: 1172
scattering by non-spherical nuclei, analysis of diffractive, (T), 20: 1153 (INR-605/VII/PL)
scattering by nuclei, distorted-wave model in elastic, (E/T), 20: 1238
DIAPHRAGMS
particle passage into lymphatics of, in mice, 20: 16
DICARBOXYLIC ACIDS
reactions with water, deuterium isotope effects on proton abstraction in, 20: 350
DICHROMATES
dichromate–nitric acid, corrosive effects on austenitic stainless steel, effects of steel composition on, 20: 767(R) (GEAP-4915)
DIES
design of differential thermal expansion, for compacting powders at high temperatures, 20: 781 (AI-65-12)
design of high temperature swaging, using magnetic pulses, 20: 781 (AI-65-12)
DIET
cesium-137 content in human, 20: 521(R) (HASL-164)
effects of phosphates in, on strontium metabolism in animals, 20: 8(R) (STI/DOC/10/42, pp 23-43)
fallout contamination at Argonne, New York, and New Zealand, 20: 521(R) (HASL-164)
radium-228 content in human, 20: 148(R) (NYO-3086-1 Pt.IV)
strontium-90 content in human infant, 20: 521(R) (HASL-164)
DIETHYLENETRIAMINE
diethylenetriamine–1,1-dimethylhydrazine, radiolysis of Hydyne rocket fuel, effects of methyl methacrylate on gas production in gamma, 20: 357 (USNRDL-TR-896)
radiolysis of liquid, effects of methyl methacrylate on gas production in gamma, 20: 357 (USNRDL-TR-896)
DIFFUSION
in gases and gas mixtures, research program on, 20: 963(R) (TID-22313)
DIOXANE
radioinduced reactions with chlorofluoroolefins, spectra of products of, 20: 395
DIRECT ENERGY CONVERSION DEVICES
design study for fission-electric cell reactor, (T), 20: 1468 (JPL-TR-32-741)
DISKS
stress analysis of rotating, (T), 20: 467
DISPLACEMENT GAGES
design, 20: 644(P)
DOGS
calcium-45 excretion by kidneys of, 20: 30
care of experimental, design of facilities for, 20: 3 (LF-23)
metabolism of bismuth-212, lead-212, and radium-224 in, from thorium-228 decay, 20: 42
mucous membranes in, toxic effects of rare earth metals in contact with, 20: 25(R) (TID-22294)
radiation dosimetry in tissues of, method for x, 20: 604
radiation effects from internally deposited radioisotopes on serum lactic dehydrogenase levels in beagles, 20: 112
radiation effects on beagle, thickness effects of central beam dose received on, 20: 113
radionuclide content and distribution in bones of, following injection, 20: 23(R) (NYO-3086-1 Pt.III)
renal clearance of bromine, chlorides, inulin, and iodides in, tracer study, 20: 37
strontium-85 excretion by kidneys of, 20: 30
virus isolation from, use of tissue cultures of canine origin for, 20: 4 (LF-26)
DOSIMETERS

calibration, for gamma rays and thermal neutrons, 20: 648 (AERE-R-4960)
glass micro-, method for tissue dosimetry in dogs, 20: 604
performance of proton-recoil fast-neutron, (T), 20: 654 (NP-15466)
use of end-window tube, for beta measurements, 20: 661
use of sulfur disk as, reduction of fast neutron threshold of criticality, 20: 647 (AERE-M-1631)
DOUNREAY FAST REACTOR
performance as irradiation facility, 20: 1503
DRESDEN POWER REACTOR
design of, comparison with Russian Kurchatov Power Reactor, 20: 1484
DRUGS
effects of strophantides on patients with Chagas disease, 20: 163(R) (STI/DOC/10/42, pp 71-127)
leukopoiesis-stimulating, effects in irradiated rats, 20: 194
DUSTS
radioactive contamination in Japan, effects of weapons testing on, 1959 to 1962, 20: 534
DYES
radiation effects on phagocytosis of sodium carmine and trypan blue by reticuloendothelial cells in tissue culture, 20: 85
DYSPROSIUM
determination of, in rare-earth mixtures, photometric, 20: 252
effects on dog and rabbit membranes of contact with, 20: 25(R) (TID-22294)
effects on rabbit skin, effects of various solvents on toxic, 20: 25(R) (TID-22294)
metabolism in feces, tissues, and urine, 20: 25(R) (TID-22294)
Seebeck effect in single crystals of, (E), 20: 1343
thermal hysteresis of magnetic transitions in polycrystalline, 20: 851
DYSPROSIUM ISOTOPES Dy-159
energy levels of, spin of ground-state, (E), 20: 1248
DYSPROSIUM ISOTOPES Dy-160
energy levels of, lifetime of, (E), 20: 1175
DYSPROSIUM ISOTOPES Dy-161
energy levels of, lifetime of, (E), 20: 1175
DYSPROSIUM NIOBATES
preparation and structure of perovskite type, 20: 844
DYSPROSIUM OXIDES
Dy_2O_3–SrO, phase studies, 20: 302
DYSPROSIUM TANTALATES
preparation and structure of perovskite type, 20: 844

E

EARTH
crust of, conference on state of stress in, 20: 513
EARTHQUAKES
energy flow from, diffusion theory of seismic, 20: 547
seismic wave propagation from, 20: 542 (NP-15557)
ECOLOGY
fallout distribution in food chain and water, monitoring and controlling, 20: 18
of bird populations, effects of high-level gamma-neutron radiation, 20: 17
radionuclide movement in animal food chains, review on, 20: 41
EGGS
radiation effects on nutritive value in animals, gamma, 20: 50
radiosensitivity of *Syngamus trachea*, 20: 70
radiosensitivity of silkworm, 20: 72
radiosensitivity of insect, 20: 83
ELECTRIC ARCS
design of short circuit spark gap for collision current installations, 20: 630
plasma jet production in, properties of, 20: 1277 (TID-22136)
ELECTRIC CONDENSERS
radiation effects of electrons on aluminum-polymer-sandwich, (E), 20: 692 (NASA-CR-312)
ELECTRIC CONDUCTORS
thermal capacity measurement in, pulse heating calorimetric technique for, 20: 827 (ORNL-P-1670)
ELECTRIC CONTROL SYSTEMS
design for monitoring breaks in control rod structure, 20: 1394(P)
ELECTRIC DISCHARGE
current pulse production in high-current, short, single, (E/T), 20: 1095
ionization wave in, forward-backward transition of, (E), 20: 1290
plasma properties in, (E), 20: 1272(R) (ORNL-3836, pp 36-66)
ELECTRIC FIELDS
charged particle motion in crossed magnetic and, (T), 20: 1266 (NP-15450)
effects on thermal conductivity of dipolar gases, (T), 20: 1085
electron and ion beams in, natural coordinate system for studying, 20: 938 (SLAC-46)
plasma containment in rotating crossed magnetic and, (E/T), 20: 1266 (NP-15450)
plasma flow in crossed magnetic and, one-dimensional, (T), 20: 1294
production of pulsed, by plasma pinch effect, 20: 1281(T) (AD-620824)
ELECTRIC GENERATORS
use of shut-down energy of turbo-, in power plant accidents, 20: 1492
ELECTRIC POWER
systems of, for foreign nuclear power plants, 20: 1507
ELECTRIC PROBES
electric impedance of cylindrical, in plasma, (T), 20: 1253 (AFCRL-65-480)
ELECTRODES
anodic overvoltages of nickel, in molten fluorides, 20: 284 (EUR-804.e)
performance of liquid-protected, in ion propulsion engines, 20: 502
ELECTROLYTES
interactions in polar organic solvents, research program on, 20: 1565(R) (RPI-1999-6)
ionic binding in solutions of, determination from tracer transfer rate coefficients, 20: 327
ELECTROLYTIC SEPARATION PROCESSES
design of cell for electrorefining plutonium, 20: 752(R) (RL-SEP-503)
ELECTROMAGNETIC FIELDS
charged-particle acceleration in solar, (T), 20: 955
coherence properties of, quantum mechanical correlation functions for, (T), 20: 1063
ELECTROMAGNETIC WAVES
emission by electron beams in ring waveguide, 20: 1001
emission in electron beam-plasma interactions, (T), 20: 1267 (NYO-2813-34)
emission of coherent, effects on stability of electron-beam spacecraft-propulsion systems, (T), 20: 499 (NP-15541)
interactions in nonequilibrium plasma, 20: 1286
interactions in plasma, 20: 1285
plasma acceleration by, 20: 1291
propagation in bounded compressible plasma, (T), 20: 1284
propagation in plasma in cylindrical magnetic field, (T), 20: 1288
ELECTROMETERS
design for ionization chamber, 20: 678(P)
ELECTRON BEAMS
detection of slowly polarized, research on, 20: 959 (AD-613546)
effects on dynamic elasticity constants of polymeric materials, 20: 406
effects on sorbed gases in metal surfaces, 20: 915 (ORNL-TM-1166)
effects on structure of polyvinyl chloride, 20: 400
effects on surgical sutures, granuloma-induction by sterilization, 20: 712
electromagnetic wave emission by, in ring waveguide, 20: 1001
focusing of, calculations of transverse oscillations in traveling-wave tube for, 20: 919
interactions with laser beams, monochromatic gamma beam production in, (E/T), 20: 936 (SLAC-41)
interactions with plasma, amplification and stability in, (E/T), 20: 1261 (ML-1184)
interactions with magnetoplasma, wave propagation from, (T), 20: 1267 (NYO-2813-34)
interactions with laser beams, nonlinear electron scattering in, (E), 20: 1003
motion in electric and magnetic fields, natural coordinate system for determining, 20: 938 (SLAC-46)
performance for space propulsion, effects of coherent radiation on, (T), 20: 499 (NP-15541)
reactions with gold–tungsten alloys, bremsstrahlung spectral distributions from, (E), 20: 651 (EGG-1183-2055)
transmission from high vacuum to higher pressure region, carbon-coated foil window for, 20: 509(P)
uses in melting molybdenum wires, 20: 858
ELECTRON PAIRS
production in germanium near threshold, cross section for, (E), 20: 1214
ELECTRONIC EQUIPMENT
radiation effects on, 20: 695
ELECTRONICS
conference on, 20: 631
ELECTRONS
absorption and scattering in inhomogenous media, photographic isodose measurements of, 20: 162 (CONF-640918-2)
acceleration of plasma, in toroidal apparatus in electric fields, (E), 20: 1257 (IAE-769)
capture by deuterons from argon, helium, and neon at 12.9 to 21.0 Mev, 20: 974
capture in proton reactions with hydrogen at 0.130 to 150 kev, resonant, 20: 971
collisions of, directory of international workers on, 20: 1563 (ORNL-AMPIC-2)
correlation energy for high-density gas of, Coulomb, 20: 975
cyclotron harmonics from helium plasma, line shape measurements for,

(E), 20: 1258 (LA-DC-7364)
density and temperature in stratified low-pressure discharge in argon and oxygen, (E), 20: 1086
detection and measurement of, energy dependence of alanine dosimeter for, 20: 394
dosimetry, role of momentum in, 20: 605
effects on aluminum-polymer-sandwich capacitors, (E), 20: 692 (NASA-CR-312)
effects on antimony- and arsenic-doped germanium, annealing, recombination, and trapping, (E), 20: 911
effects on carcinomas, therapeutic, 20: 205
effects on crosslinking of regenerated cellulose fabrics with N-methylol compounds, 20: 358(T) (NP-tr-1299)
effects on crystalline choline chloride, radical termination mechanisms in, 20: 378
effects on diffusion of gases in polyethylene, 20: 407
effects on dislocations in copper at low temperatures, 20: 897
effects on electric conductivity of gold, impurity effects on recovery of, 20: 900
effects on lattice perturbations in semiconductors, 20: 908
effects on microwave polarization in plasma, (E), 20: 1292
effects on radiothermoluminescence of butadiene elastomers, 20: 366
effects on *Streptococcus faecium*, 20: 69
effects on yield stress increase in aluminum at 23°K, 20: 896
effects with and without uv rays on aluminum, glass, paint, and stainless steel, 20: 910
energy levels of gas of, in magnetic fields, 20: 921
gamma interactions with K-shell, of tin, tantalum, and lead, 20: 978
interactions with electrons and positrons, polarization effects in, (T), 20: 996 (NP-15204)
interactions with phonons in crystals containing defects, (T), 20: 1342
interactions with positrons via W bosons, differential cross section for, (T), 20: 1018
kinetics in irradiated dipolar systems, (T), 20: 370
momentum/velocity ratio of fast, relativity-theory tests by, (E), 20: 1117
motion in metals, photon-scattering analysis of plasma resonances in, (T), 20: 1326 (ORNL-P-1600)
oscillations in plasma, electric-discharge-induced, (E), 20: 1254 (ARL-65-151)
paramagnetic resonance in alkyl radicals from gamma-irradiated organic glass, 20: 371
phase oscillations in synchrotrons, resonance of, (E/T), 20: 941
polarization and scattering asymmetries of beta-decay, Mott technique for, (T), 20: 1249
polarization of, research on, 20: 959 (AD-613546)
reactions with Apollo spacecraft wall sections at 0.75 and 1.25 Mev, bremsstrahlung dose rates and spectra from, 20: 1306 (NASA-TM-X-1140)
reactions with atoms, excitation and ionization cross sections for, 20: 976
reactions with neopentane gases, products from, 20: 369
reactions with single crystals of copper, orientation effects on K x-ray emission in, (E), 20: 1331
scattering by aluminum foils, temperature dependence of elastic, (E), 20: 981
scattering by beryllium-9, form factor for M1 transition in inelastic, (T), 20: 1222
scattering by bismuth at 150 and 300 Mev, cross sections for, (E), 20: 913 (LAL-1142)
scattering by hydrogen, angular distributions for inelastic, (T), 20: 970
scattering by laser beams, nonlinear, (E), 20: 1003
scattering by n-heptane, methane, and propane at 70 ev, energy distributions and total cross sections for inelastic, 20: 335
scattering by nuclei, cross sections for elastic, (T), 20: 1156 (JINR-P-2370)
scattering by oxygen-16, fine structure of giant dipole resonance in inelastic, (E/T), 20: 1184
scattering by polar molecules at low energy, cross sections for, (T), 20: 973
scattering by three-nucleon systems, structure studies by, 20: 1234
scattering by water at low energy, cross sections for, (T), 20: 973
scattering on nuclei, polarization effects in, (T), 20: 996 (NP-15204)
transfer in aqueous solutions and biological systems, Grotthuss mechanisms in, 20: 340
transport in shielding materials, formulation of, (T), 20: 1303 (AD-614250)

ELECTROSTATIC GENERATORS
design of tandem type, 20: 948(P)

ELEMENTARY PARTICLES
angular distributions of secondary, in high-energy interactions, (E), 20: 984 (IAE-574)
annihilation of pairs of, photon emission in electromagnetic, 20: 1024
astronomical problems and physics of, 20: 1036(T)
beta decay of, sum rules for axial-vector coupling-constant renormalization in, 20: 1066
book: *Philosophical Problems of Elementary Particle Physics*, 20: 1032(T)
decays of, Ademollo-Gatto theorem for strangeness nonconserving, 20: 1072
detection of high-energy, equipment developments in, 20: 649 (BNL-9543)
development of theory of, 20: 1046(T)
development of theory of, information theory for, 20: 1051(T)
developments in theory and experiment for, 20: 1049(T)
field theory of, spontaneous symmetry breakdown in axiomatic, 20: 1070
interaction amplitudes for, integral representations of relativistic, (T), 20: 1053 (JINR-P-2321)
interactions in nonrelativistic three-body system of spinless, U_8 symmetry for, (T), 20: 1058
interactions of heavy, matrix elements for inelastic, (T), 20: 1054 (JINR-P-2328)
interactions of scalar, with gravitational field, cross sections for, (T), 20: 1077
interactions of, Lorentz invariance and total-spin-conservation in, (T), 20: 1068
interactions of, relation between weak and strong, 20: 1076
interactions of, time delay in nonrelativistic, (T), 20: 1067
interactions of, univalent functions for analytic properties of forward amplitude of, 20: 1065
interactions of, vacuum Regge pole in scalar-vector field theory for, 20: 1081
interactions of, WKB approximation for semiclassical behavior of Regge poles in, 20: 1079
mass quantization of half-spin, 20: 1059
model construction for, 20: 1050(T)
model for, vector-meson decays as test of nonrelativistic quark, (T), 20: 1016
models for, octet enhancement in bootstrap, 20: 1064
momentum of, spark chamber ladder counter for analyzing, 20: 653 (LAL-1143)
polarization of decay, in two-step process, (T), 20: 1013
properties and structure from statistical regularities of, 20: 1047(T)
quantum theory and transmutability of, 20: 1045(T)
quantum theory for, causality and determinism in, 20: 1048(T)
quantum theory for, joint coordinate-momentum representation of, 20: 1080(T)
quantum theory of, 20: 1035(T)
quantum theory of problem of elementarity in, 20: 1038(T)
research, 20: 991(R) (CEAL-1023)
research on high-energy physics, report of Joint Committee on Atomic Energy on, 20: 1241
scattering amplitudes and spin-parity determination, (T), 20: 1078
structure of, criterion of relative elementarity in, 20: 1041(T)
structure of, internal, 20: 1037(T)
structure of, spatial, 20: 1040(T)
symmetries for, structure of vertex parts in SL(6) and $\bar{U}(12)$, (T), 20: 1055 (JINR-P-2338)
symmetries of, rigorous, (T), 20: 1060
symmetry group for, representation of SU(3), (T), 20: 1056 (NP-15536)
symmetry groups for, irreducible representations of SU(3), 20: 1073
theory of, conservation principles in, 20: 1039(T)
theory of, contemporary development of, 20: 1034(T)
theory of, physical theories and development of contemporary, 20: 1033(T)
theory of, space-time properties in, 20: 1042(T)
theory of, space-time quantization in, 20: 1043(T)
theory of, space-time in, 20: 1044(T)

ELEMENTS
analysis for impurities, using spark-source mass spectrometry, 20: 235 (Y-KG-28)
determination using radioisotopes, calibration curves, optimum conditions, and sensitivity of quantitative, 20: 245
radiation absorption by, 20: 923
vapor pressures of, from groups IV, V, VI, VII, and VIII, 20: 331

ELK RIVER POWER REACTOR
development of, technical specifications for, 20: 1459 (CEND-515)
fission product release by stack at, 20: 1547 (CEND-512)
operation of, summary of July to Dec. 1964, 20: 1453(R) (ACNP-65532)
radiation release from, stack monitoring of, 20: 1452 (ACNP-63628)
safety analysis, 20: 1459 (CEND-515)

EMBRYOS
effects of x-irradiated on growth of Rous sarcoma virus on chorioallantoic membrane of chick, 20: 103
radiation effects on nervous system development in rat, 20: 60(R) (NYO-901-37, pp 33-68)
radiation effects on rat, pathological, 20: 60(R) (NYO-901-37, pp 33-68)
radiosensitivity of hematopoietic cells of liver of mouse, 20: 96

ENGINEERING TEST REACTOR

operation summary for, cycles 71 and 72, 20: 889(R) (BNWL-120, pp 4.1-59)
ENTROPY
equation for, convergence of iterative solution of integral, (T), 20: 1083 (MATT-368)
ENZYMES
adaptive changes in, physiological factors, 20: 57(R) (NYO-901-37, pp 7-13)
effects of liver, physiological, 20: 57(R) (NYO-901-37, pp 7-13)
radiation effects on hydrolysis in beef heart muscle, x, 20: 63(R) (STI/DOC/10/42, pp 45-55)
radiation effects on, protective effects of colloidal sulfur, 20: 137
radioinduced inactivation of carboxypeptidase A, energy dependence of x, 20: 46 (PRNC-40)
radiosterilization of pectic, x, 20: 63(R) (STI/DOC/10/42, pp 45-55)
EPITHELIUM
radiation dose to rat, natural background, 20: 151(R) (NYO-3086-1 Pt.VII)
radiosensitivity of, of mussels, *Unio crassus*, 20: 139
ERBIUM
determination of, in rare-earth mixtures, photometric, 20: 252
Seebeck effect in single crystals of, (E), 20: 1343
ERBIUM ISOTOPES Er-165
energy levels of, hyperfine structure and nuclear moments and spins of, (E), 20: 1248
ERBIUM ISOTOPES Er-169
beta decay of, internal conversion coefficient from, (E), 20: 1251
ERBIUM OXIDES
properties of nonstoichiometric, magnetic and paramagnetic, 20: 880
Er_2O_3–SrO, phase studies, 20: 302
ERBIUM TITANATES
crystal structure of, x-ray and neutron diffraction studies of, 20: 298
ERYTHROCYTES
radiation dose from iron-55, 20: 153(R) (NYO-3086-1 Pt.X)
ESCHERICHIA COLI
radiation effects on, protective effects of phosphate polymers against, 20: 8(R) (STI/DOC/10/42, pp 23-43)
radioinduced bacteriophage in, ultraviolet, 20: 127
ESTERS
radiation effects on elasticity of polymers, 20: 406
ESTRADIOL
radiolysis of, in aqueous sodium hydroxide, products from, 20: 396
ESTROGENS
radiolysis of, in aqueous sodium hydroxide, products from, 20: 396
ETHANE
ethane–O, radiation effects on production of ethyl hydroperoxide in, 20: 248
ETHANE, CHLORO-
effects on radioinduced polymerization of methyl acrylate in triethylamine and tetrahydrofuran at –78°C, 20: 405
radioinduced polymerization of methyl acrylate in solutions of, at 25 to –78°C, 20: 404
radioinduced polymerization of methyl acrylate with styrene and acrylonitrile in solutions of, at 0 to –78°C, 20: 404
ETHANOL
oxidation by peroxydisulfate ions in aqueous solution, kinetics of, 20: 1571(R) (TID-22186)
reactions with anhydrous praseodymium and neodymium chlorides to form alcoholates, 20: 316
ethanol–H_2O, deuterium isotope rate effects of solvolysis of substituted bromo- and chlorohydrocarbons in, 20: 336
ethanol–H_2O, equivalent conductivity of hydrochloric acid in, 20: 336
ETHYL ETHER
radioinduced reactions with chlorofluoroolefins, spectra of products of, 20: 395
ETHYL HYDROPEROXIDE
radioinduced in ethane–oxygen mixtures, iodometric analysis of mixture with hydrogen peroxide, 20: 248
reactions with potassium iodide in mixture with hydrogen peroxide, iodometric analysis of, 20: 248
ETHYLENE
effects on radiolysis of cyclohexane vapor at 100°C, mechanism of, 20: 377
radioinduced telomerization with isobutane and methanol at high pressure and temperature, beta, 20: 355(R) (NYO-2978-42)
ETHYLENE, CHLORO- POLYMERS
radiation and ultraviolet effects in, comparison of, gamma, 20: 384
radiation effects on structure, 20: 400
radiation effects on elasticity of hardened, 20: 406
radioinduced graft polymerization of acrylonitrile on, 20: 401
use for coatings on space vehicles, 20: 384
ETHYLENE, DICHLORO-
radioinduced polymerization with isobutylene at 0, –38, and –78°C, effects of zinc oxide on, 20: 403
ETHYLENE, 1,2-DICHLORO-1,2-DIFLUORO-
radioinduced reactions with dioxane, ethyl ether, and tetrahydrofuran, spectra of products of, 20: 395
ETHYLENE, 1,1-DICHLORO-2,2-DIFLUORO-
radioinduced reactions with dioxane, ethyl ether, and tetrahydrofuran, spectra of products of, 20: 395
ETHYLENE GLYCOL
diacetate, radiolysis of, 20: 361
ETHYLENE POLYMERS
packaging for irradiated fish, effects on clostridium toxin production of, 20: 707
positron lifetime in irradiated, 20: 1002
radiation effects on, mechanism of radical decay in, 20: 385
radiation effects on diffusion of argon, helium, and nitrogen in, 20: 407
radioinduced crosslinking of, effect of nitrous oxide on, 20: 402
with propene, radioinduced crosslinking of, effects of nitrous oxide on, 20: 402
with propylene, radioinduced polymerization with methyl methacrylate, 20: 367
ETHYLENE, TETRACHLORO-
radioinduced graft polymerization of acrylonitrile on, 20: 401
ETHYLENE, TETRAFLUORO- POLYMERS
use in extraction chromatography of metal ions, 20: 433 (INP-412/C)
ETHYLENE, TRICHLOROFLUORO-
radioinduced reactions with dioxane, ethyl ether, and tetrahydrofuran, spectra of products of, 20: 395
EUGLENA
radioinduced inactivation of colony formation in, ultraviolet, 20: 129
EUROPE
fallout monitoring in foodstuffs, 1963, 20: 144 (EUR-2460.d,f,i,n)
nuclear energy utilization in, 20: 1469 (KFK-359)
radioactivity levels in fossil fuels from, 20: 152(R) (NYO-3086-1 Pt.VIII)
EUROPIUM
determination in lithium chloride and lithium iodide, polarographic, 20: 249
determination of, in rare-earth mixtures, photometric, 20: 252
EUROPIUM CARBIDES
vaporization of EuC_2, 20: 811 (AERE-R-5012)
EUROPIUM CHLORIDES
stability and ion pairing, 20: 299
EUROPIUM ISOTOPES Eu-153
energy levels, (E), 20: 1178
energy levels of, lifetime of, (E), 20: 1175
EUROPIUM ISOTOPES Eu-156
distribution from nuclear excavation in basalt, 20: 613
EUROPIUM OXIDES
phase transition of, pressure effect on ferromagnetic, 20: 1328
Eu_2O_3–SrO, phase studies, 20: 302
EUROPIUM OXYBROMIDES
preparation and structure of, 20: 869
EUROPIUM SULFATES
stability and ion pairing, 20: 299
EVAPORATORS
development for preparation of thin-film isotopic targets, 20: 696(R) (ORNL-3829)
EXHAUST SYSTEMS
filter design for radioactive materials in, 20: 518
EXPERIMENTAL BOILING WATER REACTOR
reactivity calculations for plutonium and uranium dioxide fueled, 20: 1457 (BNWL-126)
EXPERIMENTAL BREEDER REACTOR
performance using plutonium loadings, 20: 1356
EXPERIMENTAL BREEDER REACTOR-II
fuel element reprocessing for, 20: 447
EXPERIMENTAL GAS COOLED REACTOR
fission product release from core, studies, 20: 581 (CONF-650407, pp 921-37)
fuel elements for, postirradiation examination of prototype, 20: 891 (GEAP-3893)
EXPLOSIONS
seismic wave propagation from, 20: 542 (NP-15557)
use of gaseous, in shock testing with controlled pulse rise times, 20: 1566 (SC-DC-65-1545)
EXPLOSIVES
shipping of, interstate regulations and permits for safe, 20: 594 (LA-DC-7469)
EYE LESIONS
radioinduced in mice, method for recording lens opacity, 20: 75
radioinduced in retina of newborn mice, x, 20: 117
EYES
radiation effects on lens crystallin protein from, γ, 20: 67

radiation effects on nucleic acid metabolism in rat lens, tracer study, 20: 89
radioinduced orbital tumors of, 20: 168
radiosensitivity of cornea of, in salamander, effects of age, 20: 82
radiosensitivity of, 20: 172
radiotherapy of tumor of, late pathological effects from, 20: 168
radiotherapy of tumors of, hazards from, 20: 172
thermal radiation shielding for, 20: 614

F

FALLOUT
contamination by meteorological factors, 20: 527
content in water and food chain, 20: 18
deposition in Australia, meteorological factors, 20: 523
dispersion in atmosphere from reactor accident, calculations, 20: 560 (CONF-650407, pp 362-80)
from TNT test of Kiwi reactor, 20: 565 (CONF-650407, pp 537-56)
from TNT test of Kiwi reactor, 20: 566 (CONF-650407, pp 557-65)
monitoring at Argonne, New York, and New Zealand, 20: 521(R) (HASL-164)
monitoring in Alaska, 1959 to 1962, 20: 525
monitoring in Canada, 1965, 20: 597 (NP-15563)
monitoring in Canada, 1965, 20: 596 (NP-15542)
monitoring in Czechoslovakia, 1959 through 1963, 20: 522
monitoring in Czechoslovakia, 1958 to 1963, 20: 533
monitoring in Czechoslovakia, 1963, 20: 536
monitoring in Czechoslovakia, 1965 to 1961, 20: 537
monitoring in Japan, 1959 to 1962, 20: 534
monitoring in West Germany, 1964, 20: 524
monitoring of, from nuclear excavation in basalt, 20: 613
pathological effects of, in Marshallese population, 20: 90
radioactivity and particle sizes in, from Chinese test explosion, 20: 535
FAST REACTORS
core test facility for molten plutonium-fueled, development of, 20: 1534(R) (LA-3370)
design for fuel testing, 20: 1546(P)
design of Russian breeder, 20: 1351 (WASH-1060)
design of supercritical water, 20: 1515
development of, for power production, 20: 1487
development review, 20: 1513
fuel development for European power, 20: 1463 (EUR-2445.f)
safety of settled-bed, 20: 1456 (BNL-9475)
FATTY ACIDS
radiation effects on liver synthesis of, x, 20: 63(R) (STI/DOC/10/42, pp 45-55)
FECES
cesium-137 content in guinea pig, following injection by different routes, 20: 33
excretion of thorium-228 decay products in beagle, 20: 42
rare earths in, residue studies of, 20: 25(R) (TID-22294)
FERMIONS
correlation functions for many-body systems of, variational method for, 20: 975
FERTILIZERS
neutron-irradiated, use of phosphorus-32-labeled, 20: 699
properties of raw phosphate, for direct application to soils, 20: 9(R) (STI/DOC/10/42, pp 61-9)
utilization of nitrogen and phosphorus by maize, radioisotope study, 20: 9(R) (STI/DOC/10/42, pp 61-9)
FETUSES
radiation protection of, during diagnostic radiography during pregnancy, 20: 187
radiosensitivity of, 20: 199
radiosensitivity of, 20: 214
FIELD THEORY
coherence properties in quantum, correlation functions for, 20: 1063
formalism of spin-2 field, Stuckelberg, 20: 1071
interactions of gravitational and scalar fields, cross sections for, 20: 1077
interactions of gravitational and generalized Yang-Mills fields in quantum, 20: 1115
noncovariance of, for Dirac monopole, 20: 1069
symmetry breakdown in axiomatic, spontaneous, 20: 1070
univalent functions for forward scattering amplitude in local, 20: 1065
FILMS
light scattering by polymeric, polarization effects in, (T), 20: 1572 (TID-22196)
thickness measurements on, accuracy of beta-backscatter and x-ray-emission, 20: 493
FILTERS
design for photographic film detectors, lead-frame and lead-lattice, 20: 658
design of drum, engineering drawings for, 20: 220
development for micron and submicron particles, 20: 518
development of medium-flow rate high-purity efficient, for particulates and iodine, 20: 589 (CONF-650407, pp 1204-15)
pore size in, determination of, 20: 728(P)
testing of high-efficiency, for suspended particles, 20: 577 (CONF-(CONF-650407, pp 805-13)
use in particle size classification of radioactive aerosols, mathematical procedure for, 20: 599 (NRL-6306)
FIRES
sodium, studies of variables and fission product release in, 20: 558 (CONF-650407, pp 94-117)
FISH
flavor in irradiated, effects of hypoxanthine on, 20: 718
radiation processing of, effects on refrigerated storage life, 20: 701 (COO-1283-27)
radiosterilization of, effects on clostridium toxin production of, 20: 707
FISSION
detection and measurement of high-energy, design of mica-sandwich detectors for, (E), 20: 652 (INR-647/I-A,VI/PH)
FISSION CHAMBERS
design of mica-sandwich, for analysis of high-energy fission, (E), 20: 652 (INR-647/I-A,VI/PH)
design of plutonium-239, 20: 696(R) (ORNL-3829)
fabrication of miniature, for neutron detection, 20: 680(P)
FISSION-COUNTING ANALYSIS
use in determination of plutonium-239, uranium-233, and uranium-235, 20: 228 (LA-DC-7439)
FISSION FRAGMENTS
energy loss in nitrogen, 20: 387
tracks of, use of, in measurement of uranium distribution in solid homogeneous critical assembly fuel, 20: 227 (KAPL-M-6448)
FISSION PRODUCTS
behavior inside and outside reactors, French safety research program on, 20: 568 (CONF-650407, pp 578-86)
charge and mass distributions from proton fission of uranium-238 at 7 to 12 Mev, (E/T), 20: 1247
collection system for gaseous HBWR, 20: 1466(R) (HPR-63)
deposition from helium stream in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
diffusion from uranium dioxide, calculations of, 20: 854
dispersion in atmosphere from reactor accident, calculations, 20: 560 (CONF-650407, pp 362-80)
distribution in KIWI reactor fuel elements, autoradiography of, 20: 1438
escape to atmosphere from different reactor accidents, analysis of, 20: 587 (CONF-650407, pp 1080-90)
release and dispersion from SNAPTRAN 2/10A-3 destructive test, 20: 564 (CONF-650407, pp 512-36)
release and transport under accident conditions, conference on, 20: 554 (CONF-650407)
release from accidents in power reactors, safety program on, 20: 571 (CONF-650407, pp 641-7)
release from coated particle fuels in gas-cooled reactors under accident conditions, 20: 556 (CONF-650407, pp 56-72)
release from double containment system in reactor, calculation of, 20: 584 (CONF-650407, pp 984-99)
release from EGCR core, studies, 20: 581 (CONF-650407, pp 921-37)
release from irradiated uranium dioxide in paste with sodium, 20: 894 (RT/CBI(65)27)
release from melted stainless-steel-clad uranium dioxide fuel elements, atmospheric effects on, 20: 559 (CONF-650407, pp 276-91)
release from nuclear excursions into atmosphere, 20: 563 (CONF-650407, pp 497-511)
release from reactor accidents to atmosphere, techniques for limiting, 20: 585 (CONF-650407, pp 1000-14)
release from sodium fires, 20: 558 (CONF-650407, pp 94-117)
release from TNT test of Kiwi reactor, 20: 566 (CONF-650407, pp 557-65)
release from Zircaloy-2-clad uranium dioxide fuel rods operated at high power rating, 20: 579 (CONF-650407, pp 885-907)
release in reactor accidents, Swedish research program on radiological consequences of, 20: 569 (CONF-650407, pp 603-8)
release in swimming pool reactors, gas collecting device for, 20: 1544(P)
release of gaseous, from defects in uranium dioxide fuel elements into coolant systems, 20: 555 (CONF-650407, pp 1-37)
release of gaseous, from irradiated clad uranium mononitride, 20: 888 (BMI-1731)
release of gaseous, from irradiated EGCR prototype fuel elements, 20: 891 (GEAP-3893)
release of gaseous, from defected uranium dioxide fuel elements of different lengths, 20: 890 (EXP-NRX-21406)
release of gaseous, from carbon-coated fuel particles at high

temperatures, 20: 899
removal from copper and brass, ultrasonic, 20: 430 (CEA-R-2823)
removal from protective coatings, 20: 573 (CONF-650407, pp 720-9)
retention and plating in liquid sodium systems, studies, 20: 557 (CONF-650407, pp 73-93)
separation from plutonium and uranium fuels during fluoride processing, 20: 432(R) (EURAEC-1402)
separation of, using mass spectrographs, 20: 434 (JUL-248-NP)
transport after loss-of-coolant accident in power reactor with pressure suppression containment, calculations, 20: 575 (CONF-650407, pp 753-75)
transport and deposition in gas stream under isothermal conditions, model for, (T), 20: 1349 (ORNL-TM-1274)
transport of delayed neutron precursor, in LS4M reactor, 20: 1539

FISSIONABLE MATERIAL
incorporation in vitreous systems for use as reactor fuel elements, 20: 1556

FLANGES
brazing of stainless steel, to sintered stainless steel filters for use at 1300°F, 20: 786 (ORNL-TM-1252)

FLOWMETERS
design for measuring coolant flow in reactors, 20: 1398(P)
design of PR-3, for high-altitude air sampling, 20: 620 (COO-401-118)

FLUID FLOW
heat transfer in two-phase, review of, 20: 486
heat transfer in, in pipes, 20: 483(R) (TID-22224)
magnetohydrodynamic, wave propagation in conducting compressible fluid in nonuniform duct, (T), 20: 1091
magnetohydrodynamic, existence principle for stationary, (T), 20: 1093
velocity fields of thermally conducting liquid helium II, (E), 20: 1130

FLUID FLOW (LAMINAR)
transition to turbulent, in subsonic plasma jets, (E), 20: 1084 (SU-247-9)

FLUID FLOW (TURBULENT)
in gas–solid suspensions, research program on, 20: 484(R) (TID-22282)
transition to laminar, in subsonic plasma jets, (E), 20: 1084 (SU-247-9)

FLUID FUEL REACTORS
design of, for power production, 20: 1486
fuel design for, paste, 20: 1447(P)
particle abrasion in, use of powdered graphite to reduce, 20: 1428(P)

FLUIDS
analysis for beta and gamma activity, apparatus for, 20: 685(P)
particle correlation functions in, statistical mechanical expressions for, (T), 20: 1082 (COO-720-053)
stability from wave propagation in semi-infinite, 20: 1094

FLUORIDE VOLATILITY PROCESSES
development for processing irradiated fuel elements, 20: 432(R) (EURAEC-1402)

FLUORINE
purification and introduction into steel cylinders, apparatus for, 20: 217 (NIJS-R-446)
reactions with perfluorodimethylcyclohexane and trichlorohepta-fluorobutane at high temperatures, 20: 346 (GAT-L-420)

FLUORINE ISOTOPES F-19
energy levels, (T), 20: 1227
nuclear magnetic resonance in manganese fluorides, critical fluctuations in, (E), 20: 1347

FLUOROFORM
reactions with plutonium and uranium hexafluorides, 20: 445

FOILS
charged-particle energy losses in thin, (E), 20: 969

FOOD
lead-210 content in vegetable, 20: 149(R) (NYO-3086-1 Pt.V)
radiation effects on nutritive value of animal, gamma, 20: 50
radiation processed, public health aspects of, 20: 709
radiation processed, inspection methods for, 20: 709
radiation processing of fish, potatoes, prunes, and strawberries, effects on storage life, 20: 701 (COO-1283-27)
radiation processing of meat, effects on clostridium spoilage, 20: 700 (AD-621921)
radiation processing of, status review, 1965, 20: 708
radiation processing of, status, 1965, 20: 719
radiosterilization of fish, effects on toxin production by *Clostridium botulinum*, 20: 707
radium-226 and -228 content in Brazilian, 20: 150(R) (NYO-3086-1 Pt.VI)

FORMIC ACID
solvent partition between aqueous and organic phases of aliphatic amines in kerosene and xylene, 20: 223 (CEA-R-2760)

FRANCE
nuclear power plant economics in coordinated networks in, 20: 1488

FREE RADICALS
decay in irradiated polyethylene, mechanism of, 20: 385
deuterium and hydrogen hyperfine splittings in organic, ratio of, 20: 315
electron paramagnetic resonance of alkyl, in γ-irradiated organic glass, 20: 371
radiation effects on formation in DNA, effects of DNA molecular weight on x, 20: 420
radioinduced in β-succinic acid single crystals, EPR spectra of, 20: 389
radioinduced in DNA and RNA, ESR spectroscopy of, 20: 421
radioinduced in sodium thiosulfate single crystals, ESR spectra of, 20: 374
termination mechanisms in radiolysis of crystalline choline chloride, 20: 378

FRENCH REACTORS
atmospheric diffusion experiments on sites of, 20: 540 (CONF-650407, pp 394-404)

FRUITS
radiation processing of prunes and strawberries, effects on storage life, 20: 701 (COO-1283-27)

FUNGI
radioinduced mutations in *Streptomyces citreus*, gamma and uv, 20: 124

FURAN, TETRAHYDRO-
effects on radioinduced polymerization of methyl acrylate at 25 to −116°C, 20: 405
effects on radioinduced polymerization of isobutylene, 20: 409
radioinduced reactions with chlorofluoroolefins, spectra of products of, 20: 395

FURNACES
design for continuous oxidation-free metal heating to high temperatures, 20: 479(P)
level control in glass, use of gamma sources in, 20: 714
wear of refractories in blast, use of cobalt-60 gamma sources for measuring, 20: 715

G

GADOLINIUM
determination of, in rare-earth mixtures, photometric, 20: 252
metabolism in feces, tissues, and urine, 20: 25(R) (TID-22294)
neutron capture (n,γ) in foils of, use in neutron radiography, 20: 621 (LA-DC-6978)
Seebeck effect in single crystals of, (E), 20: 1343
thermal hysteresis of magnetic transitions in polycrystalline, 20: 851

GADOLINIUM ISOTOPES Gd-149
alpha spectra, (E), 20: 1220

GADOLINIUM ISOTOPES Gd-153
energy levels of, spin of ground-state, (E), 20: 1248

GADOLINIUM ISOTOPES Gd-156
energy levels of, lifetime of, (E), 20: 1175

GADOLINIUM NIOBATES
preparation and structure of perovskite type, 20: 844

GADOLINIUM OXIDES
properties of nonstoichiometric, magnetic and paramagnetic, 20: 880
Gd_2O_3–SrO, phase studies, 20: 302

GADOLINIUM TANTALATES
preparation and structure of perovskite type, 20: 844

GAGES
design of time-constant control system for radiometric, 20: 640(P)

GALAXIES
formation of spiral arms in differentially rotating disk, (T), 20: 953

GALLIUM
contents in iron meteorites, 20: 530

GALLIUM ALLOYS
Ga–Nb, crystal structure of intermetallic compounds in, 20: 871
Ga–Pu, fatigue behavior of delta-stabilized, effects of metallurgical condition on, 20: 816 (BNWL-SA-210)
Ga–Pu, phase transformation of cored and homogenized, pressure-induced delta–alpha, 20: 815 (BNWL-SA-209)
Ga–Pu, properties of, 20: 815 (BNWL-SA-209)
Ga–Pu, separation of plutonium from, by Lamex process, 20: 443
Ga–Ta, crystal structure of intermetallic compounds in, 20: 871
Ga–V, crystal structure of intermetallic compounds in, 20: 871
Sb–Ga, radiation damage in semiconducting, electron and neutron, 20: 908

GALLIUM ARSENIDES
radiation effects on semiconducting, lattice perturbations from, 20: 908

GALLIUM OXIDES
preparation for isotopic targets, 20: 696(R) (ORNL-3829)

GAMETES
radioinduced mutations in, maximum permissible dose from x, 20: 107

GAMMA ABSORPTION COEFFICIENTS
for pine wood, effects of moisture content, 20: 1313

GAMMA CAMERAS
design of scintillation, 20: 668

GAMMA RADIATION
absorption in well-type scintillation detectors, probability for total, 20: 676

angular distributions from neutron reactions (n,γ) with mercury-199, (E), 20: 1152 (IFA-RN-21)
attenuation coefficients in forages and grains, (E/T), 20: 716
detection and measurement of, stability of polyacrylamide and polyisobutylene for, 20: 391
detection and measurement of, energy dependence of alanine dosimeter for, 20: 394
detection and measurement of, development of solid-state rate meter for, 20: 646 (AD-614432)
detection and measurement of, engineering drawings for, 20: 673
detection and measurement in fluid samples, apparatus for, 20: 685(P)
detection and measurement of, ionization chamber for, 20: 688(P)
detection and measurement near reactors, monitor for, 20: 1362
dose buildup factors for concretes, (T), 20: 1311 (RT/PIMA(65)2)
effects on anthracene oil and terphenyl mixture, 20: 356 (SGAE-CH-19/1965)
effects on aqueous chloride solutions, 20: 360
effects on aqueous solutions, 20: 63(R) (STI/DOC/10/42, pp 45-55)
effects on β-succinic acid single crystals, EPR spectra of, 20: 389
effects on carbohydrate and protein metabolism in brains, 20: 115
effects on carbon dioxide decomposition on oxide semiconductors, products in, 20: 413
effects on catalytic activity of nickel oxide, 20: 362
effects on collagen synthesis by subcutaneous granulomas in rats, 20: 52
effects on crystalline choline chloride, radical termination mechanisms in, 20: 378
effects on cyclohexane vapor at 100°C, effects of additives on, 20: 377
effects on diethylenetriamine, dimethylhydrazine, and their mixtures, 20: 357 (USNRDL-TR-896)
effects on diffusion of gases in polyethylene, 20: 407
effects on dipolar systems, behavior of ion spurs and tracks in, (T), 20: 370
effects on DNA in bacteria, 20: 45(R) (EUR-2471.1)
effects on dynamic elasticity constants of polymeric materials, 20: 406
effects on ecology of bird populations of high-level, 20: 17
effects on *Escherichia coli*, protective effects of phosphate polymers against, 20: 8(R) (STI/DOC/10/42, pp 23-43)
effects on estrone and estradiol, 20: 396
effects on ethyl hydroperoxide and methyl hydroperoxide production in ethane and methane systems with oxygen, 20: 248
effects on ethylene glycol diacetate, yields in, 20: 361
effects on fluoroalcohols, ESR in, 20: 372
effects on growth of yeast cells, regeneration ability in, 20: 79
effects on growth of *Vicia faba* roots, of continuous low dose-rate exposure, 20: 87
effects on growth of glioblastoma cells, in culture, 20: 101
effects on heart function of, from injected gold-198, 20: 213
effects on hydrogen *ortho-para* conversion and hydrogen–deuterium equilibration, 20: 368
effects on immune reactions to transplanted kidneys, 20: 125
effects on isomerization of polyisoprene in benzene solution and in solid state, 20: 364
effects on lens crystallin protein, 20: 67
effects on liquid nitrogen tetroxide, effects of nitric oxide and oxygen on yields in, 20: 380
effects on mice, protective effects of bone marrow transplants against, 20: 133
effects on mitotic index in rat liver, whole-body, 20: 95
effects on mouse heart, pathological, 20: 102
effects on mouse kidneys, pathological, 20: 102
effects on mouse liver, pathological, 20: 102
effects on mutations in bacteriophage, 20: 80
effects on mutation induction in *Streptomyces citreus*, 20: 124
effects on nutritive value of animal foods, gamma, 20: 50
effects on optical inversion of L-glutamate residues in poly-α,L-glutamic acid, 20: 47
effects on oral cancers, therapeutic, 20: 175
effects on organic glass, EPR of alkyl radicals from, (E), 20: 371
effects on oxidation and reduction of iron ions in aqueous solutions, effects of acidity on, 20: 388
effects on oxidation of sulfuric acid by oxygen, dose rate effects on, 20: 412
effects on pea seeds, genetic, 20: 81
effects on phosphors, dose dependence of, 20: 669
effects on pocket mice, mechanisms of, 20: 114
effects on polymerization of 1,3-cyclohexadiene and 1,2-dimethylenecyclohexane, 20: 383
effects on polymerization of liquid and solid ketene dimer, 20: 398
effects on polymerization of isobutylene with vinylidene chloride at 0, −39, and −78°C in presence of zinc oxide, 20: 403
effects on polymerization of 2-methylpropene at −78°C in presence of solid additives, 20: 403
effects on polymerization of methyl acrylate and copolymerization with styrene and acrylonitrile at 0 and −78°C, 20: 404
effects on polymerization of methyl acrylate in triethylamine and tetrahydrofuran solutions at 25 to −116°C, 20: 405
effects on polymerization of isobutylene at −78°C in various organic solvents, 20: 409
effects on populations of navel orangeworm, *Paramyelois transitella*, lethal, 20: 83
effects on positron lifetime in polyethylene, 20: 1002
effects on production of 2-arylphenanthroxazoles from monoimine of phenanthrene-9,10-quinone, 20: 397
effects on seedling growth from irradiated seeds of *Zea mays*, 20: 109
effects on silkworm eggs, lethal, 20: 72
effects on *Streptococcus faecium*, biological, 20: 69
effects on structure of solid ribonuclease, 20: 53
effects on survival in mice, 20: 105
effects on toxin production by *Clostridium botulinum* in packaged fish, 20: 707
effects on trithiane, orientation of twinned polythiomethylene obtained by, 20: 353
effects on zeolites in presence of oxygen, ESR spectra of, 20: 375
gravitational effects on, Mössbauer measurement of, 20: 1114
induced spectroscopic and chemical changes in polyvinyl chloride, 20: 384
interactions with K-shell electrons of tin, tantalum and lead, 20: 978
interactions with protons, one-dimensional dispersion relations for Compton, (T), 20: 1026
measurement of, calorimeters for, 20: 1466(R) (HPR-63)
photographic film detector with multi-element filters, design of energy-independent, 20: 658
production of monochromatic, from electron-laser beam interactions, (E/T), 20: 936 (SLAC-41)
reflection of, image source method for calculating, 20: 1061
scattering by concretes at 0.6 to 7 Mev, albedo dose for, 20: 1309 (RRA-T46)
scattering by phosphorus-31, properties of 7.14-Mev level from, (E), 20: 1203
scattering experiments on, 20: 959 (AD-613546)
scattering in aluminum at 1 Mev, Fermi age from, (T), 20: 1322
scattering in expanded media, multiple, (T), 20: 1321
scattering in expanded media, multiple, (T), 20: 1322
scattering in underground concrete structures, methods for calculating, (E/T), 20: 1307 (RRA-M45)
scattering in underground concrete structures, calculations for, (E/T), 20: 1308 (RRA-T41)
scattering in underground concrete and iron structures, methods for calculating, (E/T), 20: 1310 (RRA-T51)
shielding against, performance of lead-filled plastics for, 20: 1319
spectra of backscattered, 20: 629
transmission from line isotopic source in infinite iron slab, dose build-up factors for, 20: 1316
transmission through steel pipe walls, thickness dependence of, (T), 20: 1320
use for therapy of cervical carcinomas, 20: 186

GAMMA SHIELDING
materials for, 20: 1314

GAMMA SOURCES
content in man, design of counting device for determining, 20: 660
design of cobalt-60, for agricultural research, 20: 697
detection and measurement of, performance of 4π counters for, 20: 666
effects of implanted cobalt-60 pellets, biological, 20: 58(R) (NYO-901-37, pp 14-30)
effects on lungs of embedded cobalt-60 wire, carcinogenic, 20: 60(R) (NYO-901-37, pp 33-68)
transport, vessel for cobalt-60 and radium, 20: 160
use for therapy of skin tumors, 20: 171
use of cobalt-60 imbedded in plastic material as, for radiotherapy, 20: 177
uses for *in situ* density measurements of deep-sea sediments, 20: 551
uses for level control in glass furnaces, 20: 714
uses for measuring wear of refractories in blast furnaces, 20: 715

GAMMA SPECTRA
intensities in backscattering, density effects on, 20: 629
measurement of, from neutron capture by nuclei, 20: 1252

GAMMA SPECTROMETERS
design of bent crystal, for burnup analysis of fuel elements, 20: 231(R) (NP-15344)
performance in measuring fission products in canned molten plutonium, 20: 1534(R) (LA-3370)
pulse pile-up rejection of scintillation, circuitry for, 20: 651 (EGG-1183-2055)
use for burnup determination on MTR-type fuel elements, 20: 1440

GAMMA SPECTROSCOPY
detectors for, performance of lithium-drifted, 20: 664

use in nondestructive determination of fission products in irradiated fuel elements, 20: 236(T) (AEC-tr-6621)
GARIGLIANO POWER REACTOR
electric system of, design review, 20: 1507
GAS COOLED REACTORS
cooling system pipes for, pressure vessel penetrations for, 20: 1387(P)
design, 20: 1435(P)
design of, for power production, 20: 1486
design with heat exchangers, 20: 1427(P)
design with improved heat exchanger assembly and servicing chamber, 20: 1430(P)
design with superheater, 20: 1518(P)
development of graphite-moderated, for power production, 20: 1482
fission product deposition in, out-of-pile study, 20: 572 (CONF-650407, pp 655-97)
fuel channel standpipes for, pressure vessel penetrations for, 20: 1387(P)
fuel element design for, self-purging, 20: 1441(P)
fuel element failure in, device for detecting, 20: 1379(P)
fuel element handling apparatus for, 20: 1399(P)
hazards estimates of fission product release from coated-particle fuels under accident conditions in, 20: 556 (CONF-650407, pp 56-72)
moderator support structure design, 20: 1404(P)
pressure vessel design for, 20: 1381(P)
GAS FLOW
chemical and thermodynamic processes in inviscid nonequilibrium, of expanded air plasma, (E/T), 20: 1297
from open end of rectangular shock tube, model study of, 20: 912 (AWRE-O-61/65)
transport processes in, generalized BGK collision model, 20: 1090
GASEOUS DIFFUSION PLANTS
waste water treatment at Oak Ridge, beta radioactivity removal in, 20: 592 (K-C-785)
GASEOUS FUEL REACTORS
use in rocket propulsion system, 20: 1532(P)
GASES
composition of, evolved during electron beam melting of niobium, tantalum, and vanadium, 20: 872
decontamination of, design of plant for, 20: 1397(P)
density of, measurement by particle backscattering, 20: 643(P)
desorption from metal surfaces by electron bombardment, 20: 915 (ORNL-TM-1166)
diffusion and thermal diffusion in mixtures of, research program on, 20: 963(R) (TID-22313)
electric field effects on thermal conductivity of dipolar, modification, (T), 20: 1085
gas–solid, flow and heat transfer in turbulent suspensions, 20: 484(R) (TID-22282)
neutron scattering in Maxwellian, average cosine for, (T), 20: 1135 (RT/FI(65)12)
GASKETS
design of bakeable seal for ultrahigh vacuum, 20: 468(P)
GASTROINTESTINAL TRACT
calcium absorption in humans with bone diseases, 20: 8(R) (STI/DOC/10/42, pp 23-43)
radiation injuries of, induced by radiotherapy, 20: 192
GEIGER-MUELLER TUBES
use of end-window, in beta dosimetry, 20: 661
GENETICS
effects on hypertension-induction in rats, 20: 1558 (BNL-9404)
GEOLOGY
conference on state of stress in earth's crust, 20: 513
GEOMAGNETIC FIELDS
coordinates of, maps and tables of, 20: 1104
effects of high-altitude atomic explosions on, (T), 20: 1102
intensity of, data tabulations for July–Dec. 1964, 20: 1108
kinetics and north-south conjugacy of bays of, 20: 1106
oscillations in, lunar effects on fF_2 and H, 20: 1109
pulsations in and near auroral zones, morphology of pc-5, 20: 1105
pulsations in, effects of ionosphere in, (T), 20: 1101
variations of, effects on F-region of ionosphere, (E/T), 20: 1099
GEOMAGNETIC STORMS
solar blast wave effects on sudden commencements of, (T), 20: 1107
GERMANIUM
photo reactions in, cross section for pair-production, (E), 20: 1214
radiation damage in, electron and neutron, 20: 908
radiation effects on antimony- and arsenic-doped, annealing, recombination, and trapping in electron, (E), 20: 911
radioinduced defects in, 20: 904
vapor pressure, 20: 331
GERMANIUM ISOTOPES Ge-78
decay, (E), 20: 1169
GERMANIUM OXIDES
preparation for isotopic targets, 20: 696(R) (ORNL-3829)
GERMANY (BADEN)
fallout monitoring, 1964, 20: 524
GLANDS
radiation effects on ultrastructure of fundus, in mice, 20: 111
GLASS
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
radiation effects on organic, EPR of alkyl radicals from gamma, 20: 371
radiation effects on, electron and uv, 20: 910
radioinduced luminescence of irradiated, thermal, 20: 382
sintering of powders of, 20: 755(T) (IS-Trans-20)
sorptive properties for krypton and xenon, physical, 20: 916(R) (SRIA-425-6)
strengthening by surface compression, 20: 817 (CONF-710)
uses in nuclear technology, 20: 1556
GLOVE BOXES
argon repurification plant for, 20: 475 (AERE-M-1491)
GLUTAMIC ACID POLYMERS
radioinduced optical inversion of L-glutamate residues in, 20: 47
GLUTEN
radiation effects on nutritive value in animals, gamma, 20: 50
GOITER
radiodiagnosis of, in children, 20: 185
GOLD
content in teeth after use in dental restorations, 20: 27
helium-3 elastic scattering at 29 Mev, polarization in, (T), 20: 1171
properties of, research program on, 20: 1562(R) (NYO-2684-39)
radiation effects on electric conductivity of, impurity effects on recovery of, 20: 900
radiation effects on electric conductivity of, proton, 20: 909
separation from hydrochloric acid solutions by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
GOLD ALLOYS
properties of, research program on, 20: 1562(R) (NYO-2684-39)
Au–Mn, thermal capacity of, magnetic hyperfine, 20: 832 (UCRL-16180)
Au–W, electron reactions with, bremsstrahlung spectral distributions from, (E), 20: 651 (EGG-1183-2055)
GOLD ISOTOPES Au-197
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173
GOLD ISOTOPES Au-198
content in teeth after use in dental restorations, autoradiographic study, 20: 27
pathological effects of injected colloids, on heart, 20: 213
use of colloids of, in diagnosis of liver diseases, 20: 174
GONADS
radiation dose from disease therapy, 20: 206
radiation effects on propylhydroperoxide reduction by filtrates of rat, 20: 54
radiation effects on mouse, histopathological gamma, 20: 105
radiation injuries of, in infantile male rats, protective effects of desoxyribonucleic acid extracts on, 20: 136
GRAPHITE
corrosion by carbon dioxide at 940 to 1740°F, 20: 1534(R) (LA-3370)
corrosion by carbon dioxide, 20: 756
design of fuel element casings of, 20: 1451(P)
fabrication of nuclear, 20: 756
fracture mechanisms, 20: 885
neutron slowing down in, without polarization loss, (T), 20: 1134 (ORNL-P-1604)
performance as moderator in AGR, 20: 1497
production of nuclear, JEN pilot plant for, 20: 790
properties for use in reactor fuel elements, 20: 852
radiation effects on corrosion by water at high temperatures, 20: 1470(R) (NP-15407)
radiation effects on physical properties, 20: 756
thermal conductivity of ATJ, EP 192 C, and TS-699 grades of, at 800 to 2200°C, 20: 823 (LA-DC-7456)
use of powdered, in liquid fluidized reactors to reduce particle abrasion, 20: 1428(P)
graphite–U, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
GRAPHITE MODERATED REACTORS
design calculation method for heterogeneous, 20: 1356
design of 300- and 1000 Mw(e) superheat, 20: 1515
design of, for power production, 20: 1486
design study of fission-electric conversion, (T), 20: 1468 (JPL-TR-32-741)
development and principles of pressure-tube, 20: 1493
development of gas-cooled, for power production, 20: 1482
GRASS
gamma attenuation coefficients for, (E/T), 20: 716
GRAVITATION

covariance principle and planetary orbit stability in relativity theory, 20: 1116
effects on gamma radiation, Mössbauer measurement of, 20: 1114
interaction of scalar waves of, with Schwarzschild metric, 20: 957
interactions with scalar field, cross sections for lowest-order, (T), 20: 1077
interactions with generalized Yang-Mills fields, quantum field theory for, 20: 1115
stability of differentially rotating gaseous disk, (T), 20: 953
stability of uniformly rotating gaseous disk, (T), 20: 952
GREAT BRITAIN
nuclear power plant economics in coordinated networks in, 20: 1488
GROUND WATERS
deuterium, oxygen-18, and tritium contents of, in karst region, Turkey, 20: 538
method for determining, neutronic, 20: 632
transport of, tracer studies of, 20: 548
GUINEA PIGS
care of experimental, design of facilities for, 20: 3 (LF-23)
cesium-137 distribution following injection by different routes in, 20: 33
GUNDREMMINGEN POWER REACTOR
development, 20: 1475(R) (TID-22223)
electric system of, design review, 20: 1507

H

HAFNIUM
chemistry of, solution, 20: 260
diffusion in hydrochloric, nitric, and perchloric acids in ion exchange form, 20: 260
separation from uranium by extraction chromatography, 20: 433 (INP-412/C)
separation from zirconium by reversed-phase chromatography, 20: 240
vapor pressure, 20: 331
HAFNIUM ALLOYS
Hf–Ta–W, cavitation damage of T-111 in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
Hf–Ta–W, thermal properties to melting point, 20: 878
HAFNIUM CHLORIDES
solvent distribution in thenoyltrifluoroacetone, 20: 260
HAFNIUM COMPLEXES
with chloride, fluoride, nitrate, and sulfate ions, stability constants for, 20: 260
HAFNIUM FLUORIDES
solvent distribution in thenoyltrifluoroacetone, 20: 260
HAFNIUM ISOTOPES Hf-181
decay, (E), 20: 1177
HAFNIUM NITRATES
solvent distribution in thenoyltrifluoroacetone, 20: 260
HAFNIUM OXIDES
use as support base for oxide catalyst for oxidation of internal combustion engine exhaust gases, 20: 343(P)
HAFNIUM SULFATES
solvent distribution in thenoyltrifluoroacetone, 20: 260
HAFNIUM SYSTEMS
C–Hf–Ni, phase studies of nickel-rich, 20: 826 (NP-15535)
C–Hf–Ta–W, cavitation damage of T-222 in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
C–Hf–Ta–W, erosion by sodium at 400, 1000, and 1500°F of T-222, 20: 769(R) (NASA-CR-54459)
HAIR
analysis for trace elements, activation, 20: 268
HALDEN BOILING REACTOR
development and operation, 20: 1466(R) (HPR-63)
HALOGENS
Joshi effect in, light intensity and frequency inversion of, 20: 920
HANDBOOKS AND MANUALS
criticality data, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
HANDLING AND STORAGE
criticality studies for reactor fuel particle, 20: 591 (GAMD-6623)
HANFORD PRODUCTION REACTORS
stack exhause processing at, using fog spray and foam, 20: 1550 (RL-SA-50)
HANFORD PRODUCTION REACTORS (N)
building design for, 20: 1511
HASTELLOY X
evaporation rate at 2050°F, 20: 762(R) (BNWL-120, pp 5.1-18)
properties for use as fuel cladding material, 20: 1467(R) (IDO-28649)
HAYNES 25 ALLOY
oxidation by air and oxygen at 1120°C, 20: 762(R) (BNWL-120, pp 5.1-18)
HEAD
radiosensitivity of face, 20: 183
HEALTH PHYSICS
measures for personnel at Elk River Power Reactor, 20: 1547 (CEND-512)
procedures in, for centralized removal of wastes from sites of accumulation, 20: 1553
program at Rocky Flats plant, 20: 154 (RFP-621)
HEART
hemodynamic studies on patients with Chagas disease, 20: 163(R) (STI/DOC/10/42, pp 71-127)
radiation effects on enzymes in homogenates and mitochondria of muscle of beef, x, 20: 63(R) (STI/DOC/10/42, pp 45-55)
radiation effects on mouse, pathological, 20: 102
radiation effects on function of, 20: 213
HEAT EXCHANGERS
design for reactors, 20: 1400(P)
design for use with solid-moderated gas-cooled reactors, 20: 1430(P)
heat transfer in SNAP reactor, model for simulating, (T), 20: 1529 (NAA-SR-Memo-10961)
heat transfer to laminar-flowing Bingham plastic in circular, with internal heat generation, 20: 490
support structure for reactor, 20: 1525(P)
HEAT EXCHANGERS (GAS-LIQUID)
leak detection device for, 20: 1427(P)
HEAT TRANSFER
analysis in two-phase flows in pipes, 20: 483(R) (TID-22224)
heat pipe design for, (E/T), 20: 1534(R) (LA-3370)
in cryogenic aluminum magnets, (T), 20: 1264 (NBS-8843)
in liquid metal systems, review of, 20: 1513
in SNAP reactors, model for simulating, (T), 20: 1529 (NAA-SR-Memo-10961)
to laminar-flowing Bingham plastic in circular tube with internal energy generation, 20: 490
HEAT TRANSFER SYSTEMS
performance of water-filled wick-return heat pipes, 20: 483(R) (TID-22224)
power supplies for boiling, 20: 1466(R) (HPR-63)
HEATERS
design of electron-bombardment, for isotopic material vaporization, 20: 696(R) (ORNL-3829)
HEAVY WATER REACTORS
design and performance of, for power production, 20: 1485
design development for CIRENE, 20: 1489
hazards of tritium oxides induced in, 20: 927
HELIUM
bismuth-212 and lead-212 transport in carrier gases of, 20: 427
deuteron reactions at 12.9 to 21.0 Mev, electron capture in, 20: 974
effects on fission product release from melted stainless-steel-clad uranium dioxide fuel elements, 20: 559 (CONF-650407, pp 276-91)
electron cyclotron harmonics from plasma of, line shape measurements for, (E), 20: 1258 (LA-DC-7364)
film transfer rates at 0.5 to 1.2°K, (E), 20: 1125
fission product deposition from, in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
flow of liquid II, through narrow channels, (E), 20: 1119 (LA-DC-7357)
performance in pulsed cryogenic systems for thermonuclear research, 20: 1263 (NBS-8817)
proton reactions at 1 to 23 kev, metastable 2S hydrogen atom production in, (E), 20: 982
purification of reactor coolant, 20: 1470(R) (NP-15407)
radiation effects on diffusion in polyethylene, 20: 407
thermodynamic properties of, (T), 20: 1265 (NBS-3346)
velocity fields of thermally conducting liquid II, (E), 20: 1130
wave functions for ground-state, convergence and eigenfunctions of Legendre expansion of Schroedinger, (T), 20: 964
HELIUM ISOTOPES He-3
content in stone meteorites, 20: 956
meson (μ^-) capture reactions with, elementary-particle model for, 20: 1207
meson (μ^-) capture by, coupling constants from, (E), 20: 1209
meson (μ^-) capture by, probability of, (T), 20: 1189
properties at cryogenic temperatures, (E/T), 20: 1118 (COO-1198-302)
proton inelastic scattering at 40 Mev, (E), 20: 1232
reactions (He-3,d) with nickel-62 and -64 at 22 Mev, angular distributions from, (E), 20: 1216
reactions with helium-3 at 500 to 1700 kev, angular distributions and cross sections for, (E), 20: 1154 (JINR-P-2323)
scattering by carbon-12, gold, and tin at 29 Mev, polarization in elastic, (T), 20: 1171
structure of, electron scattering studies of, 20: 1234
use in quantum resonance magnetometer for ambient fields, 20: 642(P)
HELIUM ISOTOPES He-4
content in stone meteorites, 20: 956

energy levels in, excited 0^+, 20: 1221
neutron scattering at 10 to 700 Mev, polarization from, (E), 20: 1134 (ORNL-P-1604)
photon reactions with, meson (π^+) production in, (E), 20: 1210
thermal capacity of hcp, (E), 20: 1336

HEMATOPOIETIC SYSTEM
physiology of cells of, 20: 61(R) (NYO-901-37, pp 69-73)
radiation effects on hemoglobin metabolism in, of chickens, 20: 76
radiosensitivity of cells of, 20: 61(R) (NYO-901-37, pp 69-73)
radiosensitivity of, in man, 20: 64 (SZS-5(1965))

HEMOGLOBIN
radiation effects on metabolism of, in chickens, 20: 76
radiation effects of *in vitro*, 20: 76

HEPARIN
ionic binding of sodium in, determination from tracer transfer rate coefficients, 20: 327

HEPTANE
electron inelastic scattering by, energy distribution and total cross sections for, 20: 335

1-HEPTANOL
dodecafluoro-, radiolysis of, ESR spectra of gamma, 20: 372

4-HEPTANONE, 3-ETHYL-
effects on radioinduced polymerization of isobutylene, 20: 409

HETEROGENEOUS REACTORS
design of boiling, for insertion into bituminous deposits in bore holes, 20: 1526(P)
fuel element failure in, device for detecting, 20: 1396(P)
fuel element failure in, monitoring system for detecting, 20: 1375(P)
fuel element handling apparatus for, 20: 1399(P)
neutron flux in beam tube of, method for increasing thermal, 20: 1386(P)

HIGH-ALTITUDE EXPLOSIONS
effects of atomic, on geomagnetic fields, (T), 20: 1102
fallout from nuclear, in Czechoslovakia, 20: 522

HIGH ENERGY INJECTION DEVICES
beam duct for DCX-2, design of, 20: 1276 (ORNL-P-1511)
particle accumulation and injection in DCX-2, 20: 1270(R) (ORNL-3836, pp 15-32)
particle accumulation and injection in DCX-1, (E), 20: 1269 (ORNL-3836, pp 1-14)

HIGH TEMPERATURE GAS COOLED REACTOR EXPERIMENT
design, 20: 1486
development and operation, Apr. 1964 to Mar. 1965, 20: 1470(R) (NP-15407)

HIPPURIC ACID, *o*-IODO-, SODIUM SALTS
distribution of iodine-131-labeled, in body compartments, 20: 163(R) (ST1/DOC/10/42, pp 71-127)

HIROSHIMA
leukemia incidence in irradiated population of, 20: 161

HOLMIUM
determination of, in rare-earth mixtures, photometric, 20: 252
metabolism in feces, tissues, and urine, 20: 25(R) (TID-22294)
Seebeck effect in single crystals of, (E), 20: 1343
thermal hysteresis of magnetic transitions in polycrystalline, 20: 851

HOLMIUM OXIDES
Ho_2O_3–SrO, phase studies, 20: 302

HOMOGENEOUS REACTORS
development of oxide-suspension, 20: 1352(T,R) (JPRS-31526)

HORMONES
effects on enzyme activity, physiological, 20: 57(R) (NYO-901-37, pp 7-13)

HUMBOLDT BAY POWER REACTOR
fission product leakage from pressure suppression containment, calculations, 20: 575 (CONF-650407, pp 753-75)

HUMIDITY
protective effects against radiosensitivity of *Serratia marcescens*, oxygen effects on, 20: 99

HYALURONIC ACID, SODIUM SALTS
ionic binding of sodium in, determination from tracer transfer rate coefficients, 20: 327

HYDRAZINE
reactions with hydrogen peroxide, study of kinetics of, 20: 1571(R) (TID-22186)

HYDRAZINE, DIMETHYL-
diethylenetriamine–1,1-dimethylhydrazine, radiolysis of Hydyne rocket fuel, effects of methyl methacrylate on gas production in gamma, 20: 357 (USNRDL-TR-896)
radiolysis of liquid, effects of methyl methacrylate on gas production in gamma, 20: 357 (USNRDL-TR-896)

HYDRAZYL, DIPHENYLPICRYL-
effects on radioinduced polymerization of methyl acrylate in triethylamine at –78°C, 20: 405
effects on yields in gamma radiolysis of ethylene glycol acetate, 20: 361

HYDRIDES
heats of formation, 20: 696(R) (ORNL-3829)

HYDRIODIC ACID
effects on radiolysis of cyclohexane vapor at 100°C, mechanism of, 20: 377
removal from air–steam mixtures by steam suppression system, 20: 576 (CONF-650407, pp 776-804
spectra in liquid xenon, absolute intensities and band structures of infrared, 20: 311

HYDROBROMIC ACID
spectra in liquid xenon, absolute intensities and band structures of infrared, 20: 311

HYDROCHLORIC ACID
conductivity in acetone–water and ethanol–water mixtures, equivalent, 20: 336
diffusion of hafnium in, in ion exchange form, 20: 261
separation of metal ions from, by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
solvent partition between aqueous and organic phases of aliphatic amines in kerosene and xylene, 20: 223 (CEA-R-2760)
sorption on clays, 20: 777
spectra in liquid xenon, absolute intensities and band structures of infrared, 20: 311

HYDROGEN
bismuth-212 and lead-212 transport in carrier gases of, 20: 427
crystal structure of normal, at low temperatures, 20: 1340
determination in Zircaloy-2, method for, 20: 766(R) (EURAEC-1445)
determination of ortho- and para-, in hydrogen–deuterium mixtures, 20: 237(T) (NP-tr-1266)
deuterium exchange with, in muscle proteins, 20: 349
deuterium exchange with, in proteins, 20: 419
deuterium exchange between liquid ammonia and gaseous, 20: 729(P)
diffusion in metals, mechanism of, 20: 1324(R) (EURAEC-1428)
diffusion in palladium, 20: 272
effects on crystal structure of oxide films on zirconium, 20: 778
effects on fission product release from melted stainless-steel-clad uranium dioxide fuel elements, 20: 559 (CONF-650407, pp 276-91)
effects on potassium–sodium corrosion of reactor loop materials, 20: 773(R) (ORNL-3859)
effects on stress corrosion cracking of type 410 stainless steel, 20: 772 (NYO-3257-1)
electric currents in plasma of, (T), 20: 1262 (NASA-CR-309)
electron inelastic scattering by, angular distributions for, (T), 20: 970
exchange equilibration with deuterium, radiation effects on alumina catalyst used in, 20: 368
exchange of deuterium between water and, apparatus for, 20: 264
exchange reactions between atomic and molecular, collision dynamics of, 20: 312
exchange with deuterium on molybdenum film, 20: 916(R) (SRIA-425-6)
exchange with tritium in alkylbenzenes, 20: 347(R) (TID-22251)
hydrogen ion reactions at 5 to 80 kev, dissociation in, 20: 977
hyperfine splittings in organic free radicals, ratio to deuterium, 20: 315
ionization of atomic and molecular, (E), 20: 961(R) (ORNL-3836, pp 67-73)
meson (π^-) absorption by bound nuclei of, (T), 20: 980
motion of plasma of, in octupole magnetic fields, (E), 20: 1256(R) (COO-1233-21)
ortho-para conversion of, radiation effects on catalytic activity of α-alumina on, 20: 368
oxidation of, deuterium effects on anodic, 20: 418
plasma of, containment in DCX-2, 20: 1270(R) (ORNL-3836, pp 15-32)
production by sodium-sea water reaction, for recovering deeply submerged objects, 20: 1567 (SC-RR-65-380)
production of 2S metastable atomic, in proton-rare gas collisions at 1 to 23 kev, (E), 20: 982
proton reactions at 0.130 to 150 kev, resonant electron capture in, (E), 20: 971
reactions with plutonium and uranium hexafluorides, 20: 445
retention in irradiated clad uranium mononitride, 20: 888 (BMI-1731)
sound velocity in liquid, quantum cell model for, 20: 1089
spectral line shift in gaseous and solid, vibrational, 20: 300
thermodynamic properties of normal and para-, (T), 20: 1265 (NBS-3346)
thermodynamic properties of shock-wave compressed, 20: 1089
yields in gamma radiolysis of cyclohexane vapor at 100°C, additive effects on, 20: 377
yields in gamma radiolysis of aqueous nitrous oxide-sodium tellurite solutions, 20: 393
yields in gamma radiolysis of aqueous potassium iodide-nitrous oxide solutions, 20: 392
yields in radiolysis of methane and propane, effects of temperature on, 20: 381

HYDROGEN IONS
hyperfine spin-spin dipole interaction in molecular, coefficient of, (T), 20: 314

production of atomic and molecular, (E), 20: 961(R) (ORNL-3836, pp 67-73)
production of high-current beams of, at 20 to 100 kev, 20: 962(R) (ORNL-3836, pp 74-80)
reactions with molecular hydrogen at 5 to 80 kev, dissociation in, 20: 977
HYDROGEN ISOTOPES
separation factors on noble metal electrodes, 20: 418
HYDROGEN PEROXIDES
reactions with hydrazine, study of kinetics of, 20: 1571(R) (TID-22186)
reactions with potassium iodide in mixtures with alkyl peroxides, iodometric analysis of, 20: 248
yields from radiolysis of aqueous solutions, effects of chloride ions on, 20: 360
yields in gamma radiolysis of aqueous potassium iodide-nitrous oxide solutions, 20: 392
yields in gamma radiolysis of aqueous nitrous oxide-sodium tellurite solutions, 20: 393
HYDROGEN SYSTEMS
Ar–H, excited states of solid, 20: 1337
H–Sc, phase studies and thermodynamics of, 20: 322
HYDROLOGY
radioisotope uses in, 20: 548
HYDROMAGNETIC WAVES
detection by magnetometers, frequency modulation in, (T), 20: 914 (NASA-TN-D-2950)
propagation in magnetosphere, (T), 20: 1100
HYDROPEROXIDES
n-propyl-, radiation effects on reduction by rat organic filtrates and serum, 20: 54
HYDROXYL IONS
effects on radioinduced formation of chlorine atoms in aqueous chloride solutions, 20: 360
polarography in molten alkali nitrates, oscillographic, 20: 285 (EUR-2496.e)
HYDROXYLAMINE
effects on deuterium exchange with hydrogen-bonded N–H groups in *N*-methylacetamide in aqueous solutions, 20: 354
HYPERFRAGMENTS
decay of heavy, meson (K) production in muonic, 20: 1225
HYPERONS (Λ^0)
beta decay of polarized, kinematics of, (T), 20: 1015
polarization in hyperon (Σ^0) decay, (T), 20: 1013
HYPERONS (Ω^-)
production in spin-½ baryon exchange, N/D method for, (T), 20: 1014
HYPERONS (Σ^0)
decay of, hyperon (Λ^0) polarization in, (T), 20: 1013
HYPERONS (Ξ^-)
magnetic moment of, magnet design for measurement of, (E), 20: 990 (BNL-9490)
HYPERTHYROIDISM
radiotherapy of, comparison of 2-thiouracil therapy and, 20: 176
radiotherapy using iodine-131, 20: 181
radiotherapy, using iodine-131, 20: 173
therapy using thyroid inhibitors, 20: 173
HYPOXANTHINE
effects on flavor alteration in irradiated fish, 20: 718

I

ICE
radiation effects on, behavior of ion spurs and tracks in alpha and gamma, (T), 20: 370
thermodynamic properties of, quasi-harmonic lattice theory of, 20: 1341
ICE-d_2
thermodynamic properties of, quasi-harmonic lattice theory of, 20: 1341
IMIDAZOLE
effects on deuterium exchange with hydrogen-bonded N–H groups in *N*-methylacetamide in aqueous solutions, 20: 354
IMMUNE REACTIONS
radiation effects on animal, effects of lymph cell transplants on, 20: 55(R) (EUR-2469.f)
radiation effects on, to parental spleen cell grafts in rats, 20: 86
radiation effects on, to tissue transplants, 20: 104
radiation effects on, to transplanted kidneys, 20: 125
radiation effects on, to bone marrow grafts, 20: 134
IMPACT SHOCK
effects on spherical shells, research program on, 20: 463(R) (SC-DC-65-1634)
rise times in explosive-gas, control of, 20: 1566 (SC-DC-65-1545)
test of re-entry vehicle during simulated overpressure blast, 20: 462 (SC-DC-65-1554)
tests of shipping containers for uranium hexafluoride, 20: 593 (KY-500)
IMPEDANCE BRIDGES
null detector for, engineering drawings of, 20: 637
IN-PILE LOOPS
design, 20: 1378(P)
fission product release from uranium dioxide fuel rods operated at high power rating in GETR Pressurized-Water, 20: 579 (CONF-650407, pp 885-907)
INCOLOY
properties of 800, for superheat fuel element cladding, 20: 907
radiation effects on mechanical properties of type 800, fast neutron, 20: 889(R) (BNWL-120, pp 4.1-59)
INCONEL
radiation effects on mechanical properties of type 600, fast neutron, 20: 889(R) (BNWL-120, pp 4.1-59)
INDEXES
on ionospheric properties, 20: 1103
INDIAN POINT POWER REACTOR
design of, comparison with Novovoronezh Power Reactor, 20: 1483
INDIUM ALLOYS
In–Pb, superconductivity in copper films on, in magnetic fields, (E), 20: 1124
InSb, transition temperature for spin-density waves in, 20: 921
In–Sn, Mössbauer effect near melting point, 20: 862
Sb–In, impurity striations in non-rotated single-crystal, grown by pulling from melt, 20: 1573 (TID-22314)
Sb–In, properties of cooled photodiode of, for measuring thermal photon noise, 20: 1293
Sb–In, radiation damage in semiconducting, electron and neutron, 20: 908
INDIUM ARSENIDES
radiation effects on semiconducting, lattice perturbations from, 20: 908
INDIUM BROMIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
INDIUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
INDIUM NITRATES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
INFORMATION RETRIEVAL SYSTEMS
development, 20: 1352(T,R) (JPRS-31526)
INOR-8
corrosion by liquid potassium–sodium in test loops, effects of hydrogen, oxygen, and temperature on, 20: 773(R) (ORNL-3859)
radiation effects on mechanical properties, fast neutron, 20: 889(R) (BNWL-120, pp 4.1-59)
INOSITOL
protective effects against radiosensitivity of *Serratia marcescens*, 20: 99
INSECTS
radiation effects on reproductive capacity of *Tribolium castaneum*, 20: 84
radiosensitivity of eggs of silkworm, 20: 72
radiosterilization of populations of navel orangeworm, *Paramyelois transitella*, 20: 83
INSTRUMENTATION
design for low-level waste pilot plant, engineering drawings for, 20: 1557
INSTRUMENTS
design of time-constant control system for x-ray analyzers and gages, 20: 640(P)
INTERFEROMETERS
design of Michelson laser-, (E), 20: 626 (SCL-DC-65-92)
INTERMETALLIC COMPOUNDS
strengthening mechanisms in, review of, 20: 887
INTERNAL COMBUSTION ENGINES
exhaust oxidation using inorganic oxide catalyst supported on a hafnia and/or zirconia base, 20: 343(P)
INTESTINE
physiology of mucosa in rat, 20: 78
radiation effects on mouse, histopathological gamma, 20: 105
radiation injuries of, induced by radiotherapy, 20: 178
radiation injuries of, induced by radiotherapy of gynecologic cancers, 20: 210
INULIN
renal clearance of, tracer study in dogs, 20: 37
IODIDES
renal clearance of, tracer study in dogs, 20: 37
IODINE
chemical behavior and species of vapor forms of radio-, studies, 20: 282 (CONF-650407, pp 1131-61)
content in irradiated fuels, burnup dependence of, 20: 1539
control of atmospheric particulate, 20: 424
deposition and diffusion in containers, technology review on, 20: 424
deposition from various environments on structural surfaces, 20: 574 (CONF-650407, pp 730-46)
deposition of vapors of, on surfaces, 20: 215 (CONF-650407, pp 142-77)

desorption of radio-, from clays and sediments by air and water, 20: 600 (ORNL-P-1581)
diffusion from containment vessels, technology review on, 20: 424
effects on radiolysis of cyclohexane vapor at 100°C, mechanism of, 20: 377
Joshi effect in, light intensity and frequency inversion of, 20: 920
metabolism of, in euthyroid patients, tracer study, 20: 36
release from irradiated fuel elements, techniques for characterization of, 20: 281 (CONF-650407, pp 1096-1109)
release from sodium fires, 20: 558 (CONF-650407, pp 94-117)
release in reactor accidents, experiments on, 20: 578 (CONF-650407, pp 830-52)
release of fission-product, from defects in uranium dioxide fuel elements into coolant systems, 20: 555 (CONF-650407, pp 1-37)
release of fission-product, from Zircaloy-2-clad uranium dioxide fuel rods operated at high power rating, 20: 579 (CONF-650407, pp 885-907)
release of fission-product, from defected uranium dioxide fuel elements of different lengths, 20: 890 (EXP-NRX-21406)
removal from air–steam mixtures by steam suppression system, 20: 576 (CONF-650407, pp 776-804)
removal from protective coatings, 20: 573 (CONF-650407, pp 720-9)
removal of vapors of, from air by activated charcoals, 20: 280 (CONF-650407, pp 869-84)
sorption of radio-, on aerosols and deposited particles, 20: 216 (CONF-650407, pp 242-75)
yields in gamma radiolysis of aqueous potassium iodide-nitrous oxide solutions, 20: 392

IODINE ISOTOPES
properties of radioactive, review on, 20: 518

IODINE ISOTOPES I-127
neutron reactions (n,γ) with, spectra from thermal, (E/T), 20: 1151 (IFA-RN-20)

IODINE ISOTOPES I-128
energy levels of, parity and spin of, (E/T), 20: 1151 (IFA-RN-20)
separation from reactor exhaust air by fog spray system, 20: 1550 (RL-SA-50)

IODINE ISOTOPES I-131
content in HBWR moderator, 20: 1466(R) (HPR-63)
content in milk, effects of deposition on pasture, 20: 598 (NP-15568)
content in milk, in Germany, 20: 524
content on pastures of, effects on milk content, 20: 598 (NP-15568)
detection and measurement of, by 4π gas counter, 20: 666
effects on hyperthyroidism, therapeutic, 20: 176
effects on mouse thyroid, pathological and physiological, 20: 62(R) (NYO-901-37, pp 74-9)
energy levels and gamma spectra from tellurium-131m decay, (E), 20: 1201
preparation of sources of mock, for gamma spectrometry, 20: 416 (NP-15525)
release from double containment system in boiling-water reactor, calculations, 20: 584 (CONF-650407, pp 984-99)
sorption by activated charcoal from air, 20: 278 (CONF-650407, pp 814-29)
use for diagnosis of liver diseases, 20: 174
use for hyperthyroidism therapy, 20: 173
use for therapy of hyperthyroidism, 20: 181
use for therapy of thyroid cancers, 20: 196
use for therapy of thyroid tumors, 20: 203
use in diagnosis of thyroid diseases, 20: 207
use in radiorenography, 20: 163(R) (STI/DOC/10/42, pp 71-127)

IODINE ISOTOPES I-133
determination in neutron-irradiated fuels, calculation of uranium-235 content from, 20: 241

IODINE ISOTOPES I-134
determination in neutron-irradiated fuels, calculation of uranium-235 content from, 20: 241

ION BEAMS
acceleration and production in plasma devices, (T), 20: 1262 (NASA-CR-309)
acceleration of, cyclotron design for, 20: 945(P)
development of 15-mlb-thrust, for spece propulsion, (E), 20: 498 (NASA-CR-54136)
interactions with plasma, ion waves from, (T), 20: 1259 (MATT-366)
motion in electric and magnetic fields, natural coordinate system for determining, 20: 938 (SLAC-46)
production of atomic and molecular hydrogen, (E), 20: 961(R) (ORNL-3836, pp 67-73)
production of high-current hydrogen, at 20 to 100 kev, 20: 962(R) (ORNL-3836, pp 74-80)

ION EXCHANGE
in soils, isotope studies, 20: 218(R) (STI/DOC/10/42, pp 1-22)

ION EXCHANGE MATERIALS
radiation effects on zeolites in presence of oxygen, ESR spectra of gamma and x, 20: 375

ION SOURCES
development of high-current 20- to 100-kev hydrogen, 20: 962(R) (ORNL-3836, pp 74-80)
pulse shortening in duoplasmatron, (E), 20: 1289

IONIZATION CHAMBERS
design and performance of parallel-plate multisection, for reactor control, 20: 1357 (ORNL-P-1432)
design of superatmospheric, for beta and gamma radiation, 20: 688(P)
design of, engineering drawings for, 20: 673
fabrication of miniature fission, for neutron detection, 20: 680(P)
response of saturated, a-c, (T), 20: 657
saturation characteristics of parallel-plate, equations for, 20: 670

IONOSPHERE
bibliography, 20: 1103
effects in geomagnetic field pulsations, (T), 20: 1101
ionization intensity in, data tabulation for July–Dec. 1964, 20: 1108
motion of F-region of, (E/T), 20: 1099

IONS
oscillations in plasma, electric-discharge-induced, (E), 20: 1254 (ARL-65-151)

IRIDIUM
vapor pressure, 20: 331

IRIDIUM ISOTOPES Ir-186
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)

IRIDIUM ISOTOPES Ir-188
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)

IRIDIUM ISOTOPES Ir-190
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)

IRIDIUM ISOTOPES Ir-191
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173

IRIDIUM ISOTOPES Ir-192
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)

IRIDIUM ISOTOPES Ir-193
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173

IRIDIUM ISOTOPES Ir-194
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)

IRON
corrosion by terphenyl, effects of chlorine and water on, 20: 777
determination as corrosion product in fuel solution of Berlin Research Reactor, 20: 1541
determination of traces of, in uranium using electron microprobe, 20: 225 (CONF-650810-2)
effects on neutral solubility of tungsten and nickel, 20: 865
effects on oxygen grain-boundary diffusion in magnesium oxide, 20: 830 (UCRL-14215)
gamma and neutron scattering in underground structures of, methods for calculating, (E/T), 20: 1310 (RRA-T51)
gamma scattering in, Compton, (T), 20: 1321
gamma transmission from line isotropic source in infinite slabs of, dose build-up factor for, 20: 1316
isomer shift as function of pressure, Mössbauer effect for, (E), 20: 1344
metabolism in high-altitude-induced polycythemia, tracer study, 20: 163(R) (STI/DOC/10/42, pp 71-127)
metabolism in man, tracer studies using iron-59 and whole-body counting, 20: 169
neutron inelastic scattering at 14.6 Mev, angular distributions, cross sections, and energy levels in, 20: 1144 (AD-614451)
radiation effects on microstructure of high-purity, fast neutron, 20: 745(R) (BNWL-120, pp 3.1-22)
reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
sorption by soil colloids, 20: 19
thermal capacity of pure, from 100 to 1400°C, 20: 827 (ORNL-P-1670)
uptake by plants, 20: 19
vapor pressure, 20: 331
vaporization of, under vacuum and forced convection conditions, (T), 20: 831 (UCRL-14274)

IRON ALLOYS
properties and structure of quenched, 20: 817 (CONF-710)
Al–Fe–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Fe–Ni, structures in shock-loaded, deformation and transformation, 20: 817 (CONF-710)
Fe–Ni–W, diffusion in sintered, 20: 865
Fe–Os, thermal capacity of, magnetic hyperfine, 20: 832 (UCRL-16180)
Fe–Pt, phase studies at 800 to 1400°C, 20: 338
Fe–Pt, platinum-195 Mössbauer effect in absorbers of, (E), 20: 1202
Fe–Pt, thermal capacity of, magnetic hyperfine, 20: 832 (UCRL-16180)
Fe–Pu, separation of plutonium from, by Lamex process, 20: 443
Fe–U, analysis for U_6Fe, method for, 20: 750(R) (NLCO-965, pp 6.1-8)

Fe–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Pd–Fe, phase studies at 800 to 1400°C, 20: 338
IRON CARBONYLS
complexes with cyclic phosphite esters, 20: 1561 (IS-T-31)
IRON(II) CHLORIDES
solubility in terphenyl, 20: 777
sorption on clays, 20: 777
IRON(III) CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
IRON IONS
electron transfer by, Grotthuss mechanism in, 20: 340
radiolysis of solutions of, gamma, 20: 63(R) (STI/DOC/10/42, pp 45-55)
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
IRON ISOTOPES Fe-54
photon reactions at 300 Mev peak, isomer production in, (E/T), 20: 1246
IRON ISOTOPES Fe-55
content and distribution in suspended matter in seaweed, 20: 612
content in human blood, 20: 153(R) (NYO-3086-1 Pt.X)
IRON ISOTOPES Fe-56
photon reactions at 300 Mev peak, isomer production in, (E/T), 20: 1246
IRON ISOTOPES Fe-57
energy level transitions in, (E), 20: 1182
gamma scattering by, attenuation of Mössbauer, 20: 1250
Mössbauer effect in cobalt single crystals, (E), 20: 1198
IRON ISOTOPES Fe-59
content and distribution in suspended matter in seaweed, 20: 612
uptake in man, effects of hepatic and pancreatic diseases on, 20: 169
use in diagnosis of blood diseases, 20: 207
IRON OXIDES
Co_3O_4–Fe_3O_4, phase studies at 800 to 1400°C, 20: 338
Fe–FeO, reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
FeO–MgO, phase studies at 800 to 1400°C, 20: 338
FeO–MnO, phase studies at 800 to 1400°C, 20: 338
Fe_3O_4–Mn_3O_4, phase studies at 800 to 1400°C, 20: 338
IRON(III) OXIDES
effects on stabilization of zirconia by calcium oxides, 20: 867
IRON SILICATES
$FeSiO_3$–$MgSiO_3$, phase studies at 800 to 1400°C, 20: 338
Fe_2SiO_4–Mg_2SiO_4, phase studies at 800 to 1400°C, 20: 338
$FeSiO_3$–$MnSiO_3$, phase studies at 800 to 1400°C, 20: 338
IRON SYSTEMS
Al–C–Fe–Si–U, radioinduced swelling in, effects of pressure on reactor, 20: 745(R) (BNWL-120, pp 3.1-22)
Al–Fe–Mg–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Mg–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Fe–D_2O, neutron spectra in laminated, fast, (E/T), 20: 1304 (AE-196)
Fe–FeO, reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
Fe–isobutylol–O–H_2SO_4–H_2O, radioinduced oxidation and reduction reactions of iron ions in, 20: 388
IRRADIATION FACILITIES
design for agricultural research, cobalt-60, 20: 697
design of strontium-90 beta, for high-pressure high-temperature chemical reactions, 20: 355(R) (NYO-2978-42)
performance of Dounreay Fast Reactor, 20: 1503
ISOTOPE EFFECTS
of deuterium on anodic oxidation of hydrogen noble metal electrodes, 20: 418
of deuterium on bond stability in DNA, 20: 14(T)
of deuterium on proton abstraction from dicarboxylic acids in water and heavy water, 20: 350
of deuterium on reactions of heavy water with diborane, 20: 306
of deuterium on solvolysis of exo-norbornyl bromide, 20: 352
on acid-base equilibrium of amines, nuclear magnetic resonance studies of, 20: 239
on decomposition of thiosulfate, 20: 297
ISOTOPE SEPARATION METHODS
thermal diffusion, engineering drawings of cells for, 20: 727
ISOTOPIC EXCHANGE
between cyclobutane and deuterium on metal films, 20: 304
ITALY
atmospheric stability criteria at meteorological stations in, 20: 515 (RT/PROT(65)17)

J

JAPAN
radiation monitoring in, 1959 to 1962, 20: 534
radioactivity levels in fossil fuels from, 20: 152(R) (NYO-3086-1 Pt.VIII)
reactor fuel development and economics in, 20: 1439
JAWS
radiation effects on growth of, in kittens, 20: 91
JET PUMPS
cavitation performance of, similarity parameter for correlation of, 20: 460 (ORNL-P-1447)
JOINTS
stress-magnitude predictions for cylinder-to-sphere, performance of winter's shell theory in, 20: 457(R) (BMI-X-276)
JOURNAL BEARINGS
design of hydrostatic, for ultra-precision applications, 20: 461 (RFP-667)

K

KETENE
radioinduced polymerization of dimer of, in liquid and solid states, 20: 398
KIDNEYS
bromine clearance by, tracer study in dogs, 20: 37
calcium excretion by, tracer study in dogs, 20: 30
chloride clearance by, tracer study in dogs, 20: 37
function tests of, comparison of radiorenography and excretory urography, 20: 163(R) (STI/DOC/10/42, pp 71-127)
histology of radio-nephritis in, 20: 190
inulin clearance by, tracer study in dogs, 20: 37
iodide clearance by, tracer study in dogs, 20: 37
radiation effects on mouse, pathological, 20: 102
radiation effects on mouse, histopathological gamma, 20: 105
radiation effects on immune reactions to transplanted, 20: 125
radiation effects on function of, 20: 190
renography of, using iodine-131-Hippuran, 20: 163(R) (STI/DOC/10/42, pp 71-127)
strontium excretion by, tracer study in dogs, 20: 30
KRYPTON
effects on radiolysis of deuterated and normal methane, 20: 379
microwave penetration through plasma of, polarization modifications in, (E), 20: 1292
sorption by glass and molybdenum film, physical, 20: 916(R) (SRIA-425-6)
KRYPTON ISOTOPES
separation by thermal diffusion, engineering drawings of cell for, 20: 727
KRYPTON ISOTOPES Kr-85
separation from other krypton isotopes by thermal diffusion, engineering drawings of equipment for, 20: 727
uses in zero-gravity propellant gage, 20: 721

L

LA CROSSE BOILING WATER REACTOR
piping for forced-circulation system of, metallurgical evaluation of clad, 20: 788 (SWRI-1228-73)
LABORATORIES
design of mobile, to teach handling and use of radioisotopes, engineering drawings for, 20: 428
waste management at Lawrence Radiation, 20: 1552 (UCRL-14320)
LABORATORY EQUIPMENT
design for Studsvik research center, 20: 1540
LACTIC ACID
effects on disproportionation of uranium(V), kinetics of, 20: 328
effects on oxidation and reduction of uranium ions in perchloric acid, disproportionation, 20: 326
LAMEX PROCESS
development and theory of, for preparation of high-purity plutonium, 20: 443
LANTHANUM
determination of, in rare-earth mixtures, photometric, 20: 252
proton reactions (p,n) at 6 to 14 Mev, neutron spectra from, (E/T), 20: 1239
LANTHANUM ALLOYS
La–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
LANTHANUM BORIDES
evaporation process of, thermodynamics of, 20: 329
LANTHANUM CARBONATES
yields from thermal decomposition of lanthanum oxalate, 20: 317
LANTHANUM CHLORIDES
stability and ion pairing, 20: 299
LANTHANUM ISOTOPES La-140
separation from irradiated chromium–uranium droplets by solvent extraction using molten magnesium, kinetic studies, 20: 292 (UCRL-16173)

LANTHANUM NIOBATES
preparation and structure of perovskite type, 20: 844
LANTHANUM OXALATES
thermal decomposition of, in vacuum, 20: 317
LANTHANUM OXIDES
yields from thermal decomposition of lanthanum oxalate, 20: 317
$BaO-La_2O_3$, phase studies, 20: 302
La_2O_3-SrO, phase studies, 20: 302
LANTHANUM SULFATES
stability and ion pairing, 20: 299
LANTHANUM TANTALATES
preparation and structure of perovskite type, 20: 844
LARVAE
radiosensitivity of *Synaganus trachea*, 19: 70
radiosensitivity of insect, 20: 83
LARYNX
radiation effects on mucosa of, pathological, 20: 166(T) (N64-20943, pp 1–8)
LATINA POWER REACTOR
electric system of, 20: 1507
LEAD
compatibility with silica glass at 900°C, 20: 1559 (BNL-9573)
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
gamma scattering by K-shell electrons, cross sections for incoherent, 20: 978
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
performance as filler in reactor shielding plastics, 20: 1319
proton total cross sections at 16.4 Mev, (E), 20: 1208
radiography of, scattering in fast neutron, 20: 667
vapor pressure, 20: 331
LEAD ALLOYS
Bi–Pb, cavitation effects on alloys at 500 and 1500°F, 20: 771 (NP-15558)
In–Pb, superconductivity in copper films on, in magnetic fields, (E), 20: 1124
Pb–Pd, phase studies at 800 to 1400°C, 20: 338
Pb–Pt, phase studies at 800 to 1400°C, 20: 338
Pb–Sn, Mössbauer effect near melting point, 20: 862
LEAD BORATE GLASS
$Al_2O_3-CuO_2$–lead borate glass, uses for conversion of irradiated fuel swarf to stable ceramic for long-term storage, 20: 1554
LEAD BROMIDES
compatibility with silica glass at 900°C, 20: 1559 (BNL-9573)
Br–Pb–$PbBr_2$, compatibility with silica glass at 900°C, 20: 1559 (BNL-9573)
LEAD CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
LEAD IONS
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
LEAD ISOTOPES Pb-206
charge state and energy loss of, from polonium-210 surface deposits, (E), 20: 426
LEAD ISOTOPES Pb-208
proton elastic scattering by, optical model parameters for distributions and polarizations from, (E/T), 20: 1157 (ORNL-P-1616)
LEAD ISOTOPES Pb-210
content in bones of radium dial painters, 20: 22(R) (NYO-3086-1 Pt.II)
content in vegetables, 20: 149(R) (NYO-3086-1 Pt.V)
radiochemical analysis, 20: 417(R) (NYO-3086-1 Pt.IX)
LEAD ISOTOPES Pb-212
metabolism in beagles from thorium-228 decay, 20: 42
transport in carrier gases, 20: 427
LEAD SILICATES
radiation effects on glass of, electric polarization from x, 20: 410
LEAD SYSTEMS
Br–Pb–$PbBr_2$, compatibility with silica glass at 900°C, 20: 1559 (BNL-9573)
LEAD TITANATES
$PbTiO_3-PbZrO_3-Nb_2O_5$, tensile strength of, 20: 828 (SC-DC-65-1588)
LEAD ZIRCONATES
$PbTiO_3-PbZrO_3-Nb_2O_5$, tensile strength of, 20: 828 (SC-DC-65-1588)
LEAKS
detection in sealed radium-226 and thorium-228 sources, 20: 601 (RCC-R-176(Add.))
LEAVES
polonium-210 content of tobacco, 20: 158
LEUKEMIA
deoxyribonucleic acid metabolism in human blood cells during, tracer study, 20: 20 (EUR-2451.e)
in man, after radiotherapy of carcinoma, 20: 94
incidence in cancer patients after radiotherapy, 20: 60(R) (NYO-901-37, pp 33-68)
proliferation in man, 20: 1 (BNL-9363)
radioinduced in man, 20: 202
radioinduced, dose relations in man, 20: 161
radioinduced, in children exposed *in utero*, 20: 214
radiotherapy of, whole-body, 20: 134
LEUKOCYTES
effects of leukopoiesis-stimulating drugs on, in rats, 20: 194
radiation effects on activity in cancer patients, effects of vitamin therapy on, 20: 191
radiation effects on formation of, in rats, 20: 194
radiosensitivity in thymic lymphocyte, effects of adrenal gland and splenic shielding on, 20: 142
radiosensitivity of chromosomes of, in tissue culture, effects of cell-cycle, 20: 88
LEVEL INDICATORS
design for liquid metals, engineering drawings for, 20: 634
design of resistance-type, for liquid metals, 20: 1367
LEVEL REGULATORS
design and operation of radiometric, for glass furnaces, 20: 714
LIGHT
effects on production of 2-arylphenanthroxazoles from monoimine of phenanthrene-9,10-quinone, 20: 397
protective effects of, against radiation injuries in mussels, 20: 139
scattering by metals, uses for analysis of electron plasma frequencies, (T), 20: 1326 (ORNL-P-1600)
scattering by polymer films, polarization effects in, (T), 20: 1572 (TID-22196)
LIGHT SOURCES
use of beta-activated, in mines, 20: 704
LIGURIAN SEA
radioactivity of upper layers of coastal sediments of, contributions to beta, 20: 526
strontium-90 content in upper layers of coastal sediments of, 20: 526
LINEAR ACCELERATORS
beam acceleration in standing-wave, normal-mode analysis of, (T), 20: 929 (BNL-9514)
design, 20: 947(P)
design and fabrication of 35-Gc electron bunching, (E/T), 20: 942
design for use in radiotherapy, 20: 157
design of tandem type, 20: 948(P)
use of electron, in nuclear structure analyses, 20: 1233
waveguide structure for, dispersion and frequency characteristics of alternating period, (T), 20: 931 (BNL-9554)
LIPIDS
metabolism of, 20: 61(R) (NYO-901-37, pp 69-73)
radiation effects on content of, in rabbit blood, 20: 77
radiation effects on metabolism of, in pigeons, 20: 110
LIQUID METAL COOLED REACTORS
control rod operating device for, 20: 1369(P)
design of, for power production, 20: 1486
LIQUIDS
bubble dynamics in boiling, (T), 20: 489
bubble growth and collapse in, (T), 20: 487
separation from solids, engineering drawings of drum filter for continuous, 20: 220
LITHIUM
plasma of, containment in DCX-2, 20: 1270(R) (ORNL-3836, pp 15-32)
use in neutron emissive targets, 20: 1143(P)
LITHIUM BROMIDES
KBr–LiBr, isotope shift of lithium resonant mode in, (E), 20: 1339
LITHIUM CHLORATES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
LITHIUM CHLORIDES
analysis for europium and ytterbium, polarographic, 20: 249
effects on properties of solutions of inorganic salts in dimethyl sulfoxide, 20: 293 (UCRL-16330)
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
use in plutonium–uranium separation, 20: 456(P)
LiCl–KCl, chlorination of uranium tetrachloride in fused, 20: 292 (UCRL-16173)
LITHIUM CHROMATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
LITHIUM FLUORIDES
crystal growth studies of, (E), 20: 287 (ORNL-P-1611)
radiation effects on thermal conductivity and lattice faults in neutron, (E), 20: 411
LiF–KF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
LiF–KF–NaF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)

LITHIUM IODIDES
analysis for europium and ytterbium, polarographic, 20: 249
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
LITHIUM ISOTOPES Li-6
gamma reactions (γ,n) at 5.7 to 32 Mev, cross sections for, (E), 20: 1217
meson (μ^-) capture reactions with, elementary-particle model for, 20: 1207
neutron reactions (n,t) with, cross sections for, (T), 20: 1180
LITHIUM ISOTOPES Li-7
neutron inelastic scattering at 14.6 Mev, angular distributions, cross sections, and energy levels in, 20: 1144 (AD-614451)
LITHIUM ISOTOPES Li-8
beta decay of, alpha emission in, (E), 20: 1176
LITHIUM LANTHANUM OXIDES
preparation and crystal structure, 20: 303
LITHIUM NITRATES
$LiNO_3$–KNO_3–$NaNO_3$, polarography of oxygen and hydroxyl ions in molten, oscillographic, 20: 285 (EUR-2496.e)
LITHIUM PRASEODYMIUM OXIDES
preparation and crystal structure, 20: 303
LITHIUM TERBIUM OXIDES
preparation and crystal structure, 20: 303
LITHIUM URANATES
crystal structure, 20: 334
LITHIUM YTTERBIUM OXIDES
preparation and crystal structure, 20: 303
LIVER
effects of enzymes of, physiological, 20: 57(R) (NYO-901-37, pp 7-13)
protective effects of deoxyribonucleic acid extracts from homologous, against radiation injuries in rats, 20: 136
radiation effects on propylhydroperoxide reduction by filtrates of rat, 20: 54
radiation effects on fatty acid synthesis in, x, 20: 63(R) (STI/DOC/10/42, pp 45-55)
radiation effects on excretion of bile acids by, tracer study in rats, 20: 78
radiation effects on mitosis in cells of rat, 20: 95
radiation effects on mouse, pathological, 20: 102
radiation effects on mouse, histopathological gamma, 20: 105
radiation effects on thiol content in rat, whole-body, 20: 108
radiation effects on DNA synthesis in rat, 20: 121
radiodiagnosis of diseases of, 20: 174
radiodiagnosis of, use of technetium-99 in scintillographic, 20: 197
radiosensitivity of tissue of rats, effects of oxygen on, 20: 95
radiosensitivity of hematopoietic cells of embryonic, 20: 96
tumor induction in human, by thorium dioxide, 20: 123
LOOPS
fission product deposition from helium stream in out-of-pile, 20: 572 (CONF-650407, pp 655-97)
power supplies for boiling, 20: 1466(R) (HPR-63)
LOS ALAMOS TURRET REACTOR
construction and equipment installation for, 20: 1534(R) (LA-3370)
LUNGS
cerium fluoride metabolism in rabbit, after intratracheal administration, tracer study, 20: 38
chemistry of pigments in, Grotthuss mechanism in, 20: 340
radiation dose to rat, natural background, 20: 151(R) (NYO-3086-1 Pt.VII)
radiation dose to, from polonium-210 in cigarette smoke, 20: 158
radiation effects on mouse, histopathological gamma, 20: 105
radioinduced tumors of, by embedded cobalt-60 wires, 20: 60(R) (NYO-901-37, pp 33-68)
radiotherapy of carcinoma of, late pathological effects on spinal cord, 20: 100
LUTETIUM
determination in aluminum–lutetium alloy, titration method for, 20: 247
determination of, in rare-earth mixtures, photometric, 20: 252
LUTETIUM ALLOYS
Al–Lu, analysis for lutetium, titration method for, 20: 247
LUTETIUM CHLORIDES
stability and ion pairing, 20: 299
LUTETIUM ISOTOPES Lu-175
energy levels of, lifetime of, (E), 20: 1175
LUTETIUM OXIDES
properties of nonstoichiometric, magnetic and paramagnetic, 20: 880
Lu_2O_3–SrO, phase studies, 20: 302
LYMPH
radiotherapy of Hodgkin's disease during pregnancy, 20: 209
LYMPH CELLS
radiation effects on formation of, 20: 1 (BNL-9363)
radiation effects immunological competence of, effects of origin on, 20: 55(R) (EUR-2469.f)
LYMPH SYSTEM
particle passage into diaphragmatic, in mice, 20: 16
physiology of cells of, 20: 61(R) (NYO-901-37, pp 69-73)
radiation effects on phagocytic activity of lymph node cells of rats, in tissue culture, 20: 85
radiation effects on metastatic cancers of lymph nodes, 20: 212
radiotherapy of metastases in nodes, evaluation of high-energy electron, 20: 205
LYSOSOMES
radiation effects on enzymes in beef heart muscle, x, 20: 63(R) (STI/DOC/10/42, pp 45-55)
LYSOZYME
deuterium–hydrogen exchange in, 20: 419
synthesis and storage of tritiated, 20: 2 (EUR-2419.1)

M

MAGNESIUM
alpha elastic scattering by, distorted-wave model in, (E/T), 20: 1238
determination in magnesium alloys, electrographic, 20: 267
effects on heterometric determination of vanadium using 5, 7-diiodo-8-hydroxyquinoline, 20: 257
proton total cross sections at 16.4 Mev, (E), 20: 1208
reactions with uranium tetrafluoride for uranium metal production, reduction, 20: 749(R) (NLCO-965, pp 1.1-5)
reactions with uranium tetrafluoride, 20: 761(P)
solvent properties for barium-140 and lanthanum-140 from irradiated chromium–uranium droplets, 20: 292 (UCRL-16173)
MAGNESIUM ALLOYS
analysis for cerium by potentiometric titration using vanadium(II) salts, 20: 274
fabrication of reactor components of, 20: 801(P)
Al–Mg, analysis for magnesium, electrographic, 20: 267
Cd–Mg–Zn, solvent properties of melts of, for plutonium and uranium, 20: 447
Mg–Ni, analysis for magnesium, electrographic, 20: 267
Mg–Zn, reactions with uranium oxide, 20: 741 (ANL-7057)
Mg–Zn, reactions with thorium dioxide, 20: 742 (ANL-7058)
Mg–Zr, phase diagram, liquidus curve of, 20: 812 (BM-RI-6673)
MAGNESIUM CERIUM NITRATES
cerium-137 nuclear orientation in, temperature scale from, 20: 1338
MAGNESIUM CHLORIDES
effects on radioinduced changes in proteins, 20: 49
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
MAGNESIUM HYPOPHOSPHITES
radiation effects on ESR in single crystals of, 20: 414
MAGNESIUM ISOTOPES Mg-24
energy levels, (T), 20: 1227
neutron inelastic scattering at 14 Mev, angular distributions for, 20: 1219
MAGNESIUM ISOTOPES Mg-25
proton inelastic scattering at 17.5 Mev, coupling effects in, (E), 20: 1192
MAGNESIUM ISOTOPES Mg-26
proton inelastic scattering at 17.5 Mev, (E), 20: 1192
MAGNESIUM OXIDES
diffusion of oxygen in grain boundaries of, effects of iron on, 20: 830 (UCRL-14215)
effects on grain boundary hardening in sintered beryllium oxide, 20: 846
effects on radioinduced polymerization of diphenylvinylphosphine oxide, 20: 408
sorptive properties of particles of, for radioiodine, 20: 216 (CONF-650407, pp 242-75)
CoO–MgO, phase studies at 800 to 1400°C, 20: 338
FeO–MgO, phase studies at 800 to 1400°C, 20: 338
NiO–MgO, phase studies at 800 to 1400°C, 20: 338
MAGNESIUM PHOSPHATES
crystal structure of, x-ray diffraction study of, 20: 232(R) (NYO-901-37, pp 80-4)
MAGNESIUM SILICATES
$FeSiO_3$–$MgSiO_3$, phase studies at 800 to 1400°C, 20: 338
MAGNESIUM SULFIDES
MgS–rare earth sulfides, crystal structure of solid solutions in, 20: 332
MAGNESIUM SYSTEMS
Al–Fe–Mg–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Mg–Si, corrosion by water and steam, 20: 763 (BNWL-125)
MAGNET COILS
stress analysis of tape-wound, (T), 20: 1264 (NBS-8843)
MAGNETIC FIELDS
analysis of, using TRIM code, (E), 20: 940 (UCRL-16382)
charged particle motion in crossed electric and, (T), 20: 1266 (NP-15450)
effects on ultrasonic wave propagation in niobium–zirconium alloys, 20: 863
electron and ion beams in, natural coordinate system for studying, 20: 938 (SLAC-46)

electron gas in, ground state of, 20: 921
measurement of ambient, using helium-3 quantum resonance magnetometer, 20: 642(P)
measurement of Cosmotron, 20: 932 (BNL-9557)
measurement of, techniques for, (E), 20: 627 (UCRL-16357)
plasma containment in rotating crossed electric and, (E/T), 20: 1266 (NP-15450)
plasma flow in crossed electric and, one-dimensional, (T), 20: 1294
plasma stability in, effects of "line-tying" on, (T), 20: 1280 (UCRL-16055)
plasma wave propagation in cylindrical, (T), 20: 1288

MAGNETIC MIRROR MACHINES
plasma properties in, (E), 20: 1272(R) (ORNL-3836, pp 36-66)

MAGNETIC MOMENTS
production in SNAP-10A, analysis of, (T), 20: 1528 (NAA-SR-11207)

MAGNETIC MONOPOLES
field theory of Dirac, impossibility of Lorentz-invariant, 20: 1069

MAGNETIC RESONANCE
book: *Quantum Radiofrequency Physics*, 20: 925(T)
method for determining free radical yield in x-irradiated DNA of various molecular weights, 20: 420

MAGNETITE CONCRETES
gamma dose buildup factors for, (T), 20: 1311 (RT/PIMA(65)2)

MAGNETOHYDRODYNAMICS
fluid flow in, existence principle for stationary, (T), 20: 1093
research programs on, 20: 1534(R) (LA-3370)
shock wave propagation in conducting incompressible fluids in magnetic fields, (T), 20: 1092
wave propagation in conducting compressible fluid in nonuniform ducts, (T), 20: 1091

MAGNETOMETERS
design for measuring ambient fields, 20: 642(P)
performance for hydromagnetic wave detection, frequency modulation in, (T), 20: 914 (NASA-TN-D-2950)
performance of, review, (E), 20: 627 (UCRL-16357)

MAGNETOSPHERE
hydromagnetic wave propagation in, (T), 20: 1100
solar wind interaction with, 20: 1098

MAGNETS
design and development of high-vacuum encapsulated, 20: 504(R) (ORNL-3836, pp 120-9)
design and performance of aluminum cryogenic, 20: 1264 (NBS-8843)
design for AGS, parameters of, (T), 20: 930 (BNL-9553)
design of cryogenic and superconducting, 20: 1120(R) (ORNL-3836, pp 90-110)
design of minimum-B superconducting, for plasma use, (E), 20: 1279 (UCRL-14233)
design of nsec ferrite-core, for synchrotron-beam switching, (E), 20: 939 (UCRL-16364)
design of superconducting, for measurement of hyperon (Ξ^-) magnetic moment, (E), 20: 990 (BNL-9490)
field analysis for, TRIM code for, (E), 20: 940 (UCRL-16382)
heat transfer in cryogenic aluminum, (T), 20: 1264 (NBS-8843)
power supply conversion of Brookhaven AGS, for beam intensity increasing, 20: 928 (BNL-9500)
refrigeration development for cryogenic, 20: 1265 (NBS-3346)
refrigeration systems for thermonuclear reactor, performance of pulsed, 20: 1263 (NBS-8817)
uses to stir solutions in diffusion cells, engineering drawings of apparatus for, 20: 221

MAIZE
fertilizer utilization by, radioisotope study of nitrogen and phosphorus, 20: 9(R) (STI/DOC/10/42, pp 61-9)
gamma attenuation coefficients for, (E/T), 20: 716
radiation effects on seedling growth of, from irradiated seeds, 20: 109

MALIC ACID COMPLEXES
with uranyl ion, polarography at 15°C, 20: 295

MAMMARY GLAND
cancers of, prognostic indications for, 20: 60(R) (NYO-901-37, pp 33-68)
radiotherapy of tumors of, pathological effects on heart, 20: 213

MAN
calcium metabolism in, effects of strontium-85 injection on, 20: 32
cesium-137 contamination in diet of, 20: 521(R) (HASL-164)
cesium-137 half-life in, 20: 521(R) (HASL-164)
chromosome patterns of, 20: 94
effects of space flight on, bibliography, 20: 56 (NASA-SP-7011(15))
iron metabolism in, tracer studies using iron-59 and whole-body counting, 20: 169
iron-55 content in blood of, 20: 153(R) (NYO-3086-1 Pt.X)
radiation effects on, diagnostic use of blood picture for determining, 20: 116
radiation effects in skin of, toxic effects of ultraviolet, 20: 74
radiation hazard from diagnostic radiography of pregnant women, 20: 214
radiation hazards of diagnostic radiography during pregnancy, 20: 195
radiation injuries in, diagnosis using of blood pictures, 20: 64 (SZS-5 (1965))
radiation monitoring in Alaskan, shadow-shielding whole-body counter for, 20: 659
radiodiagnosis hazards to, 20: 202
radioinduced chromosome aberrations in, 20: 60(R) (NYO-901-37, pp 33-68)
radioinduced leukemia in, dose relations, 20: 161
radium-226 content in body and bones of, 20: 603
radium-228 in diet of, 20: 148(R) (NYO-3086-1 Pt.IV)
scandium-46 decontamination in, DTPA and EDTA for, 20: 31
strontium-85 content following intravenous injection in, 20: 32
strontium-90 body burdens in, review of methods for estimating, 20: 32
strontium-90 content in diet of infant, 20: 521(R) (HASL-164)
thermal radiation temperature measurements in skin of, 20: 614
tumor induction in liver in, by thorium dioxide, 20: 123
zinc-65 content of, from consumption of Pacific Ocean oysters, 20: 553 (BNWL-SA-293)

MANGANESE
metabolism in chickens, tracer study, 20: 29
sorption by soil colloids, 20: 19
thermal capacity of gamma, magnetic hyperfine, 20: 832 (UCRL-16180)
uptake by plants, 20: 19
vapor pressure, 20: 331

MANGANESE ALLOYS
Al–Mn–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Au–Mn, thermal capacity of, magnetic hyperfine, 20: 832 (UCRL-16180)
Co–Mn–U, phase diagrams, intermetallic compounds in, 20: 874
Cu–Mn, thermal capacity below 1°K, 20: 832 (UCRL-16180)
Mn–Pt, phase studies at 800 to 1400°C, 20: 338
Mn–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873

MANGANESE FLUORIDES
fluorine-19 NMR in, critical fluctuations in, (E), 20: 1347

MANGANESE ISOTOPES Mn-52
hyperfine structure and magnetic moment of isomeric, (E), 20: 1204
metabolism in chickens, 20: 29
photoproduction of isomeric, yield ratios for, (E/T), 20: 1246

MANGANESE ISOTOPES Mn-54
metabolism in chickens, 20: 29

MANGANESE ISOTOPES Mn-55
photon reactions at 300 Mev peak, isomer production in, (E/T), 20: 1246

MANGANESE OXIDES
Co_3O_4–Mn_3O_4, phase studies at 800 to 1400°C, 20: 338
CoO–MnO, phase studies at 800 to 1400°C, 20: 338
FeO–MnO, phase studies at 800 to 1400°C, 20: 338
Fe_3O_4–Mn_3O_4, phase studies at 800 to 1400°C, 20: 338
MnO–NiO, phase studies at 800 to 1400°C, 20: 338

MANGANESE SILICATES
Fe_2SiO_4–Mn_2SiO_4, phase studies at 800 to 1400°C, 20: 338
$FeSiO_3$–$MnSiO_3$, phase studies at 800 to 1400°C, 20: 338

MANGANESE SULFIDES
MnS–rare earth sulfides, crystal structure of solid solutions in, 20: 332

MANNITOL
effects on renal transport of calcium and strontium in dogs, osmotic-diuresis, 20: 30

MARCOULE REACTORS
performance of, review of, 20: 1482

MARITIME REACTORS
design of, review of, 20: 1422

MARSHALL ISLANDS
pathological effects of fallout in population of, ten-years post-exposure, 20: 90

MASERS
book: *Quantum Radiofrequency Physics*, 20: 925(T)

MASERS (OPTICAL)
beam interactions with electron beams, monochromatic gamma beam production in, (E/T), 20: 936 (SLAC-41)
design of Michelson laser interferometer, (E), 20: 626 (SCL-DC-65-92)
electron scattering by beams from, nonlinear, (E), 20: 1003
use in pulse measurements of thermal conductivity at high temperatures, 20: 823 (LA-DC-7456)

MASS SPECTROMETERS
design and construction of time-of-flight, for neutron scattering studies, 20: 1144 (AD-614451)
design of delayed warm-up filament power supply for, 20: 641(P)
resolution of, for separation of fission products, 20: 434 (JUL-248-NP)
use of spark-source, in analysis of alloys and elements, 20: 235 (Y-KG-28)

MATERIALS TESTING

fracture toughness of irradiated materials, evaluation of double cantilever beam method for, 20: 889(R) (BNWL-120, pp 4.1-59)
methods of nondestructive, for pressure vessels, 20: 1366
radiation hazards from welding, 20: 606
shock, control of pulse rise times in explosive-gas, 20: 1566 (SC-DC-65-1545)
MATHEMATICS
book: *Conclusions of Mathematical Sciences*, Vol. 37, 20: 924
classification of non-compact real simple Lie groups, 20: 738
coordinate systems in, development for vector problems, 20: 938 (SLAC-46)
equations in, method for finding extrema of, (T), 20: 734 (JINR-P-1988)
Hankel functions of imaginary argument, tables of spherical, 20: 735 (NRL-6288)
Hilbert spaces of analytic functions, 20: 736
operators in Hilbert space, 20: 737
reduced matrix element of an irreducible spherical tensor operator for, derivation of, 20: 1329
representations of 2 + 1 Lorentz group, 20: 739
representations of continuous groups, 20: 740
Schroedinger operators in three-dimensional Euclidian space, (T), 20: 1111
use of group theory in nuclear theory, 20: 1236
MATTER
conservation principles and structure of, 20: 1039(T)
neutrino motion in superdense, (T), 20: 951 (NP-15517)
quantum theory in development of, 20: 1045(T)
space-time properties of, 20: 1042(T)
stability from wave propagation in semi-infinite, 20: 1094
MEATS
radiation processing of, effects of sodium nitrate plus sodium chloride additive on spoilage by *C. botulinum* during refrigerated storage after, 20: 700 (AD-621921)
MECHANICAL ENGINEERING
strain analysis using moire fringe technique, 20: 1574 (UCRL-13156)
MECHANICS
book: *Developments in Theoretical and Applied Mechanics*. Vol. 1, 20: 926
correlation functions in classical statistical, (T), 20: 1082 (COO-720-053)
variational principles in, analogies in neutron diffusion theory, 20: 1136
MEDICAL SUPPLIES
radiosterilization of surgical sutures, 20: 703
radiosterilization of sutures, unfavorable tissue reactions to, 20: 712
MEDICINE
radiation and radioisotopes in, Russian conference on, 20: 11(T) (AEC-tr-6293)
radiation exposure of dentists, effects on health and fertility, 20: 59(R) (NYO-901-37, pp 31-2)
MEMBRANES
effects of rare earth metals in contact with dog and rabbit, 20: 25(R) (TID-22294)
growth of virus on chick embryo chorioallantoic, 20: 103
MERCAPTO GROUP
radiation effects on content in rat skin, uv, 20: 93
MERCURY
content in teeth after use in dental restorations, 20: 27
separation from hydrochloric and nitric acid solutions by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
separation from nitric acid by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
use in dissolution of aluminum and aluminum--uranium alloy plates, 20: 438 (RT/CHI(65)23)
vapor supersaturation during expansion in nozzle, design of experiment on, 20: 481 (NAA-SR-Memo-11194)
MERCURY CHLORIDE COMPLEXES
with adenylic acid oligomers, 20: 1575 (UCRL-16409)
MERCURY IONS
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
MERCURY ISOTOPES Hg-192
spectra of, isotope shift in, (E), 20: 1245
MERCURY ISOTOPES Hg-193
hyperfine structure and isotope shift of isomeric, (E), 20: 1245
MERCURY ISOTOPES Hg-194
spectra of, isotope shift in, (E), 20: 1245
MERCURY ISOTOPES Hg-195
hyperfine structure and isotope shift, (E), 20: 1245
MERCURY ISOTOPES Hg-196
energy level structure, (E), 20: 1173
spectra of, isotope shift in, (E), 20: 1245
MERCURY ISOTOPES Hg-197
hyperfine structure and isotope shift, (E), 20: 1245
MERCURY ISOTOPES Hg-198
spectra of, isotope shift in, (E), 20: 1245
MERCURY ISOTOPES Hg-199
neutron reactions (n,γ) with gamma angular distributions from thermal, (E), 20: 1152 (IFA-RN-21)
MERCURY ISOTOPES Hg-200
energy levels of, parity and spin of, (E), 20: 1152 (IFA-RN-21)
MERCURY ISOTOPES Hg-203
use in diagnosis of brain tumors, 20: 179
MESIC ATOMS
production of (μ), 20: 1225
production of meson (π^-), in hydrogenous material, (T), 20: 980
MESITYLENE
effects on radiolysis of monoimine of phenanthrene-9,10-quinone, 20: 397
MESONS
decay of, matrix elements for leptonic, (T), 20: 1055 (JINR-P-2338)
interactions of charged scalar, with neutral vector mesons, vacuum Regge pole in annihilation, 20: 1081
interactions of pseudoscalar, with baryons, SU(6) model for cross sections for, 20: 1017
interactions with mesons, sum rules for, (T), 20: 1004
interactions with baryons, testing SU(6) symmetry by, (T), 20: 1006
interactions with baryons, broken W(3) symmetry model for, 20: 1075
MESONS, RESONANCE
decay of K*, test of nonrelativistic quark model in radiative, (T), 20: 1016
decay of vector, test of nonrelativistic quark model in radiative, (T), 20: 1016
decay of, resonance widths and SU(3) symmetry predictions for strong, (E/T), 20: 1025
interactions of neutral vector, with charged scalar mesons, vacuum Regge pole in annihilation, 20: 1081
production of K*, in meson (K*) interactions with neutrons and protons at 2.3 Bev/c, (E), 20: 1010
MESONS (η)
lifetime, (T), 20: 1005
MESONS (η^0)
decay modes, (E), 20: 1027
lifetime of, from bremsstrahlung spectra, 20: 1023
production in meson (π^+)-proton interactions at 1.2 Bev/c, (E), 20: 1027
MESONS (K)
decay of, SU(3) symmetry for 2π, (E), 20: 1022
momentum/velocity ratio of fast, relativity-theory tests by, (E), 20: 1117
production in meson (π^-) reactions with emulsion nuclei at 7.2 Bev/c, cross sections for, 20: 1224
MESONS (K^-)
interactions with protons, decay-hyperon (Λ^0) polarization in ($\pi^0\Sigma^0$), (T), 20: 1013
interactions with protons, SU(6) model for cross sections for, 20: 1017
MESONS (K^0)
decay of K_2^0, violation of time reversal invariance in, 20: 918
decay of, CP violation and regeneration in, (E/T), 20: 1021
MESONS (K^+)
decay of, $\Delta I = \frac{1}{2}$ rule in 3π, (E), 20: 1028
decay of, SU(3) symmetry for 2π, (E), 20: 1022
interactions with neutrons at 2.3 Bev/c, charge-exchange, (E), 20: 1009
interactions with deuterons at 2.3 Bev/c, (E), 20: 1009
MESONS (K^+_{τ})
decay of, $\Delta I = \frac{1}{2}$ rule in, (E), 20: 1028
decay of, energy spectra from, (E), 20: 1011
MESONS (μ^-)
capture by helium-3, probability of, (T), 20: 1189
capture by nuclei, elementary-particle model for, 20: 1207
capture reactions with helium-3, coupling constants from, (E), 20: 1209
MESONS (ω)
production in meson (π^+)-proton interactions at 2.77 Bev/c, (E), 20: 1019
MESONS (ω^0)
decay of, test of nonrelativistic quark model in radiative, (T), 20: 1016
MESONS (ϕ)
decay of, test of nonrelativistic quark model in radiative, (T), 20: 1016
MESONS (π)
interactions with mesons (π), sum rules for, (T), 20: 1004
interactions with mesons (π), strip approximation for meson (ρ) trajectory in, (T), 20: 1012
interactions with mesons (π), field theory for amplitudes of meson (ρ) production in, 20: 1030
interactions with mesons (π) and protons, partially conserved axial vector current in, 20: 1066
momentum/velocity ratio of fast, relativity-theory tests by, (E), 20: 1117
MESONS (π^-)
absorption by bound hydrogen nuclei, (T), 20: 980
absorption by carbon-12 at rest, (T), 20: 1193
energy spectra from meson ($K_{\frac{1}{2}3}$) decay, (E), 20: 1011

interactions with protons, SU(6) model for cross sections for, 20: 1017
interactions with protons at 3.7 Bev/c, diffraction scattering effects in, (E), 20: 1008
reactions with emulsion nuclei at 7.2 Bev/c, meson (K) production in, (E), 20: 1224

MESONS (π^0)
decay of, 3γ, (E), 20: 1007

MESONS (π^+)
energy spectra from meson ($K_{\mu 3}$) decay, (E), 20: 1011
interactions with protons at 3.65 Bev/c, diffraction scattering effects in, (E), 20: 1008
interactions with protons at 2.77 Bev/c, double resonance production in, (E), 20: 1019
interactions with protons at 1.2 Bev/c, meson (γ^0) production in, (E), 20: 1027
photoproduction on helium-4, (E), 20: 1210
production and transverse momentum distributions in proton-proton interactions at 11.6 to 22.9 Bev/c, (E/T), 20: 1031

MESONS (ρ)
decay of, test of nonrelativistic quark model in radiative, (T), 20: 1016
production in meson (π)-meson (π) interactions, strip approximation for trajectory of, (T), 20: 1012
production in meson (π)-meson (π) interactions, field theory for amplitudes of, 20: 1030

MESONS (ρ^+)
decay of, test of nonrelativistic quark model in radiative, (T), 20: 1016
production in meson (π^+)-proton interactions at 2.77 Bev/c, (E), 20: 1019

METABOLISM
of vitamin B_{12}, tracer study using cobalt-57, 20: 28
radiation effects on lipid, in pigeons, 20: 110

METAL COMPACTS
mechanical properties of, of tungsten fibers in copper matrix, 20: 884
production of fiber-reinforced, 20: 760

METALLIC FILMS
electron scattering by, uses for analysis of electron plasma frequencies in metals, (T), 20: 1326 (ORNL-P-1600)
superconductivity in copper, on superconducting indium–lead alloys in magnetic fields, (E), 20: 1124

METALLIC FILTERS
brazing of sintered stainless steel, to stainless steel flanges for use at 1300°F, 20: 786 (ORNL-TM-1252)

METALLOGRAPHY
etching technique for plutonium, electrolytic swab, 20: 751 (RFP-543)

METALLURGY
plasma jet uses in, 20: 1277 (TID-22136)
radioisotope uses in industrial, 20: 706
research programs at Battelle-Northwest, 20: 744(R) (BNWL-120)

METALS
conference on high-strength, 20: 817 (CONF-710)
corrosion cracking in, mechanisms of transgranular stress-, 20: 779
diffusion of hydrogen in, mechanism of, 20: 1324(R) (EURAEC-1428)
electron plasma resonances in, analysis using photon scattering, (T), 20: 1326 (ORNL-P-1600)
heating of, design of furnace for oxidation-free, 20: 479(P)
level indicator for liquid, design of, 20: 1367
levels of liquid, engineering drawings of equipment for measuring, 20: 634
mechanical properties at low temperatures, review of, 20: 883
properties of liquid, review of engineering, 20: 486
research programs on high-temperature liquid, review of, 20: 743 (BNL-939)
separation from hydrochloric and nitric acid solutions by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
vapor pressures of, 20: 331

METASTASES
radiotherapy of lymph node, evaluation of supervoltage, 20: 205

METEORITES
age estimation of chondrites and chondrules, rubidium–strontium, 20: 529
age estimations for, cosmic ray exposure and helium–thorium–uranium, 20: 956
gallium contents in iron, 20: 530
isotopic composition and content of, helium and neon, 20: 956

METEOROLOGICAL INSTRUMENTS
design of constant-temperature wind component meter, 20: 516 (TID-22278)

METEOROLOGY
atmosphere stability at Italian stations, 20: 515 (RT/PROT(65)17)
effects on fallout transport, 20: 523
effects on fallout distribution, 20: 527
effluent flow around buildings, 20: 562 (CONF-650407, pp 455-9)
hurricane air mixing calculations, based on tritium content of air, 20: 519
hurricane energy input calculations, based on tritium content of rain water, 20: 519

METHACRYLIC ACID, METHYL ESTER
effects on radiolysis of diethylenetriamine, dimethylhydrazine, and their mixtures, 20: 357 (USNRDL-TR-896)
radioinduced polymerization with isobutylene and ethylene–propylene rubber, 20: 367

METHACRYLIC ACID, METHYL ESTER POLYMERS
radiation effects on elasticity of hardened, 20: 406

METHANE
bismuth-212 and lead-212 transport in carrier gases of, 20: 427
electron inelastic scattering by, energy distribution and total cross sections for, 20: 335
ionization potential of, (E), 20: 351
neutron scattering by liquid, use of Langevin equation of Brownian motion for analysis of cold and slow, 20: 313
radiolysis of deuterated and normal, sensitized by argon, krypton, and xenon, 20: 379
radiolysis of, effects of temperature on hydrogen yields in, 20: 381
tritium exchange with water, 20: 469(R) (ORNL-TM-1275)
methane–O, radiation effects on production of methyl hydroperoxide in, 20: 248

METHANE, CHLORODIPHENYL-
substituted, deuterium isotope rate effects on solvolysis in acetone–water and ethanol–water mixtures, 20: 336

METHANE, CHLOROTRIFLUORO-
reactions with plutonium and uranium hexafluorides, 20: 445

METHANE, DICHLORO-
effects on radioinduced polymerization of isobutylene, 20: 409

METHANE, DICHLORODIFLUORO-
effects on radioinduced polymerization of isobutylene, 20: 409
reactions with plutonium and uranium hexafluorides, 20: 445

METHANE, IODO-
removal from air by activated charcoals, 20: 280 (CONF-650407, pp 869-84)
removal from air–steam mixtures by steam suppression system, 20: 576 (CONF-650407, pp 776-804)
removal from gases by sorption on charcoals, 20: 279 (CONF-650407, pp 852-68)

METHANE, TRICHLOROFLUORO-
reactions with plutonium and uranium hexafluorides, 20: 445

METHANE, TRIS(HYDROXYMETHYLAMINO)-
effects on deuterium exchange with hydrogen-bonded N–H groups in *N*-methylacetamide in aqueous solutions, 20: 354

METHANETHIOL
neutron scattering cross sections for gaseous and liquid, total, (E), 20: 325

METHANOL
neutron scattering cross sections for gaseous and liquid, total, (E), 20: 325
oxidation by peroxydisulfate ions in aqueous solution, kinetics of, 20: 1571(R) (TID-22186)
radioinduced reactions with ethylene at high pressure and temperature, beta, 20: 355(R) (NYO-2978-42)
reactions with anhydrous praseodymium and neodymium chlorides to form alcoholates, 20: 316
methanol–HNO_3, use as eluant in separation of americium and curium by anion exchange, 20: 439(T) (ORNL-tr-893)

METHIONINE
radiation effects on content in proteins, gamma, 20: 50

METHOXYAMINE
effects on deuterium exchange with hydrogen bonded N–H groups in *N*-methylacetamide in aqueous solutions, 20: 354

METHYL HYDROPEROXIDE
radioinduced in methane–oxygen mixture, iodometric analysis of mixture with hydrogen peroxide, 20: 248
reactions with potassium iodide in mixture with hydrogen peroxide, iodometric analysis of, 20: 248

METHYL PEROXIDE
reactions with potassium iodide in mixture with hydrogen peroxide, iodometric analysis of, 20: 248

METHYL SULFOXIDE
properties of solutions of inorganic salts in, 20: 293 (UCRL-16330)

METHYLENE SULFIDE POLYMERS
radioinduced from trithiane, orientation of twinned, 20: 353

METHYLTHYMOL BLUE
analytical use in determination of rare earths, 20: 252

MICA
performance of sandwiches of, as detectors of high-energy fission, (E), 20: 652 (INR-647/1-A,VI/PH)

MICE
care of experimental, design of facilities for, 20: 3 (LF-23)
effects of plutonium-239 in, pathological, 20: 60(R) (NYO-901-37,

pp 33-68)
iodine-131 effects on thyroid gland of, pathological, 20: 62(R) (NYO-901-37, pp 74-9)
particle passage into diaphragmatic lymphatics from peritoneal cavity of, role of endothelial cells in, 20: 16
radiation effects of implanted cobalt-60 pellets in, biological, 20: 58(R) (NYO-901-37, pp 14-30)
radiation effects on spermatogenesis in, x, 20: 65(R) (TID-22174)
radiation effects on heart, kidneys, and liver of, pathological, 20: 102
radiation effects on survival in, gamma, 20: 105
radiation effects on ultrastructure of gastric fundus glands of, whole-body, 20: 111
radiation effects on retina in newborn, x, 20: 117
radiation effects on Ehrlich ascites cells in, comparison of radiomimetics with x, 20: 118
radiation effects on, protective effects of bone marrow transplants against, 20: 133
radiation effects on, protective effects of bone marrow grafts against lethal, 20: 138
radiation effects, pathological, 20: 60(R) (NYO-901-37, pp 33-68)
radiation injuries, protective effects of sodium cysteinetheiosulfonate, 20: 130
radiation injuries of sarcomas in, protective effects of cysteinethiosulfonate, 20: 131
radioinduced chromosomal aberrations in, x, 20: 65(R) (TID-22174)
radioinduced lens opacity in, method for recording, 20: 75
radioinduced sterility in, x, 20: 65(R) (TID-22174)
radioinduced tumors of, after injections of radioactive thymidine, 20: 66 (TID-22292)
radiosensitivity of pocket, mechanisms of, 20: 114
radiosensitivity of hematopoietic cells of liver of embryos of, 20: 96
radiosensitivity of bone marrow cells in adult, 20: 96

MICROANALYSIS
chopped-beam method for trace analysis using electron probe, 20: 225 (CONF-650810-2)
equipment for electron-probe, for highly radioactive samples, 20: 224 (CNLM-6352)

MICROWAVE EQUIPMENT
electromagnetic wave emission by electron beams in ring waveguide, 20: 1001
electron beam oscillations in traveling-wave tubes, 20: 919
operation in standing-wave linacs, normal-mode analysis of, (T), 20: 929 (BNL-9514)
waveguide all-metal vacuum gate valve, design of, 20: 949(P)
waveguide coupling seal for, 20: 645(P)

MICROWAVE SPECTROSCOPY
book: *Quantum Radiofrequency Physics*, 20: 925(T)

MILK
cesium-137 content in Canadian, 1965, 20: 596 (NP-15542)
cesium-137 content of Canadian, 1965, 20: 597 (NP-15563)
cesium-137 content of, in Germany, 20: 524
cesium-137, potassium-40, radium-226, and strontium-90 contents in, in Australia, 20: 156
fallout contamination at Argonne, New York, and New Zealand, 20: 521(R) (HASL-164)
iodine-131 content in, effects of contamination of pasture and dietary factors on, 20: 598 (NP-15568)
iodine-131 content of, in Germany, 20: 524
strontium-89 content of, in Germany, 20: 524
strontium-90 content in Canadian, 1965, 20: 596 (NP-15542)
strontium-90 content of, in Germany, 20: 524
strontium-90 content of Canadian, 1965, 20: 597 (NP-15563)
strontium-90 transfer through, to young rats, 20: 35

MINERALS
sorptive properties for cesium, review of selective, 20: 1555

MINING
light sources for use in, use of beta-emitting radioisotopes in, 20: 704
stimulation of natural gas reservoirs, Gasbuggy experiment on nuclear, 20: 470 (PNE-1000)
use of nuclear explosions in, 20: 469(R) (ORNL-TM-1275)

MITOCHONDRIA
radiation effects on enzymes in beef heart muscle, x, 20: 63(R) (STI/DOC/10/42, pp 45-55)

MITOMYCINS
effects on radioinduced chromosome aberrations in plant cells, 20: 71

MITOSIS
effects of AET on, in rat bone marrow, 20: 143
effects on deoxyribonucleic acid metabolism in human blood cells during leukemia, tracer study, 20: 20 (EUR-2451.e)
effects on radiosensitivity of chromosomes in leukocytes in tissue culture, 20: 88
radiation effects on, in rat liver cells, 20: 95

MOLDS
radiation effects on *Aspergillus foetidus* and its pectic enzymes, 20: 63(R) (STI/DOC/10/42, pp 45-55)

MOLECULAR STRUCTURE
reduced matrix element of an irreducible spherical tensor operator for, derivation of, 20: 1329

MOLECULAR WEIGHTS
effects on free radical formation in x-irradiated DNA, 20: 420

MOLECULES
collisions of, directory of international workers on, 20: 1563 (ORNL-AMPIC-2)
electron scattering by polar, cross sections for low-energy, (T), 20: 973
exchange reactions with atoms, collision dynamics of, 20: 312

MOLLUSKS
radiation injuries in mussels, 20: 139
strontium-90 uptake and release in *Nerita forskali* Recluz in seawater, 20: 218(R) (STI/DOC/10/42, pp 1-22)

MOLTEN SALT REACTORS
core structure of, design of, 20: 1423

MOLYBDENUM
bibliography on, 20: 753 (SB-415(Suppl. 1))
deformation properties of single-crystal, 20: 745(R) (BNWL-120, pp 3.1-22)
effects on isotopic exchange between cyclobutane and deuterium, 20: 304
electric conductivity at 0 to 2300°C, 20: 821 (GE-TM-65-10-1)
etching dislocations on oriented single-crystal faces of, 20: 866
hydrogen–deuterium exchange on films of, 20: 916(R) (SRIA-425-6)
preparation of pure, 20: 819(R) (GA-6413)
radiation effects on dislocation channeling in, effects of pre-strain on fast neutron, 20: 745(R) (BNWL-120, pp 3.1-22)
radiation effects on structure of, combined effect of carbon impurity atoms on neutron, 20: 895
radioinduced swelling in, effects of carbon on fast neutron, 20: 745(R) (BNWL-120, pp 3.1-22)
separation from carrier-free niobium, method for, 20: 262
sorptive properties for krypton and xenon, physical, 20: 916(R) (SRIA-425-6)
tensile properties of electron-beam melted, arc-melted, and sintered wires, 20: 858
thermal conductivity at 900 to 1975°C, 20: 821 (GE-TM-65-10-1)
vapor pressure, 20: 331
vaporization of, under vacuum and forced convection conditions, (T), 20: 831 (UCRL-14274)

MOLYBDENUM ALLOYS
bibliography on, 20: 753 (SB-415(Suppl. 1))
Mo–Nb–V–Zr, thermal properties to melting point, 20: 878
Mo–Ti, cavitation damage in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
Mo–Ti–Zr, erosion by sodium at 400, 1000, and 1500°F of TZM, 20: 769(R) (NASA-CR-54459)
Mo–Ti–Zr, fatigue behavior at high temperatures in ultrahigh vacuum, 20: 824(R) (NASA-CR-54458)
Mo–Ti–Zr, fatigue in sodium at 1000 and 1500°F of TZM, high-frequency, 20: 769(R) (NASA-CR-54459)
Mo–Ti–Zr, thermal properties to melting point, 20: 878

MOLYBDENUM CARBONYLS
complexes with cyclic phosphite esters, 20: 1561 (IS-T-31)

MOLYBDENUM COMPOUNDS
bibliography on, 20: 753 (SB-415(Suppl. 1))

MOLYBDENUM ISOTOPES Mo-99
decay of, low energy isomer in, (E), 20: 1159 (UCRL-16306)

MOLYBDENUM ISOTOPES Mo-95
energy levels of, lifetime of, (E), 20: 1175

MOLYBDENUM ISOTOPES Mo-99
distribution from nuclear excavation in basalt, 20: 613
use for diagnosis of liver diseases, 20: 174

MOLYBDENUM NITRIDES
spectra of, isotope shifts in, (E), 20: 965

MOLYBDENUM OXIDES
reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
spectra of, isotope shifts in, (E), 20: 965
Mo–MoO_2, reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)

MOLYBDENUM SYSTEMS
C–Mo–Nb–Ta–W–Zr, erosion by sodium at 400, 1000, and 1500°F of Cb-132M, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–W–Zr, thermal properties to melting point, 20: 878
C–Mo–W–Zr, thermal properties to melting point, 20: 878
Mo–MoO_2, reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
Mo–UO_2, diffusion and reactions in, 20: 339

MOMENTS

determination of nuclear, using optical double resonance, 20: 1237
MONKEYS
radiation effects on learning behavior of Rhesus, sex factors, 20: 92
radiation effects on, protective effects on, protective effects of cysteine–AET against, 20: 140
MOON
effects on geomagnetic field fF_2 and H, 20: 1109
nuclear power plant on, conversion systems for, 20: 1516
MÖSSBAUER EFFECT
crystal recoil in, average value theorem for, (T), 20: 1162(T) (AD-619487)
measurement of, technique for, (E), 20: 1250
measurement of, techniques in, 20: 1166
MOUND LAB., MIAMISBURG, OHIO
environs monitoring, Jan. through June, 1965, 20: 595(R) (MLM-1275)
MOUTH
radiotherapy of cancers of, evaluation, 20: 175
MUCOSA
physiology of intestinal, in rats, 20: 78
radiation effects on laryngeal, pathological, 20: 166(T) (N64-20943, pp 1–8)
MUSCLES
cesium-137 content in guinea pig, following injection by different routes, 20: 33
contraction of, Grotthuss mechanism in, 20: 349
deuterium–hydrogen exchange in proteins of, 20: 349
radiation effects on propylhydroperoxide reduction by filtrates of rat, 20: 54
MUTAGENS
effects of ethyl methane sulfonate, on pea seeds, 20: 81
MUTATIONS
chemically induced, of peas, 20: 81
effects of water-d_2 on replication of western equine encephalitis virus, 20: 39
radiation effects on bacteriophage, gamma and x, 20: 80
radioinduced in gametes, maximum permissible dose from x, 20: 107
radioinduced in organisms, effects of, 20: 106
radioinduced in peas, 20: 81
radioinduced in plant cells, 20: 71
radioinduced in *Streptomyces citreus*, gamma and uv, 20: 124

N

NAGASAKI
leukemia incidence in irradiated population of, 20: 161
NAPHTHALENE, DECAHYDRO-
radioinduced cracking at high pressure and temperature, beta, 20: 355(R) (NYO-2978-42)
NAPHTHALENES
effects on radiolysis of monoimine of phenanthrene-9,10-quinone, 20: 397
NATURAL WATERS
radium-226 and -228 content in Brazilian, 20: 150(R) (NYO-3086-1 Pt.VI)
NAVAL REACTORS
fuel elements for, fabrication of thermionic, 20: 1437(R) (GEST-2047)
NEMATODES
radiation effects on *Syngamus trachea*, x, 20: 70
NEODYMIUM
determination of, in rare-earth mixtures, photometric, 20: 252
effects on dog and rabbit membranes of contact with, 20: 25(R) (TID-22294)
effects on rabbit skin, effects of various solvents on toxic, 20: 25(R) (TID-22294)
ionization and oxidation on rhenium and tungsten in oxygen atmosphere, 20: 757
metabolism in feces, tissues, and urine, 20: 25(R) (TID-22294)
oxidation of, heats of reaction for, (E), 20: 757
NEODYMIUM ALLOYS
Nd–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
NEODYMIUM CHLORIDES
preparation of alcoholates, 20: 316
NEODYMIUM ISOTOPES Nd-147
distribution from nuclear excavation in basalt, 20: 613
NEODYMIUM NIOBATES
preparation and structure of perovskite type, 20: 844
NEODYMIUM OXIDES
Nd_2O_3–SrO, phase studies, 20: 302
NEODYMIUM SELENIDES
electric properties, 20: 868
NEODYMIUM TANTALATES
preparation and structure of perovskite type, 20: 844
NEON
deuteron reactions at 12.9 to 21.0 Mev, electron capture in, 20: 974
microwave penetration through plasma of, polarization modifications in, (E), 20: 1292
proton reactions at 1 to 23 kev, metastable 2S hydrogen atom production in, (E), 20: 982
NEON ISOTOPES Ne-20
content in stone meteorites, 20: 956
energy levels, (T), 20: 1227
NEON ISOTOPES Ne-21
content in stone meteorites, 20: 956
NEON ISOTOPES Ne-22
content in stone meteorites, 20: 956
NEPTUNIUM
separation from thorium by ion exchange followed by solvent extraction using trioctyl phosphine oxide, 20: 242
NEPTUNIUM ISOTOPES Np-237
charge state and energy loss of, from americium-241 surface deposits, (E), 20: 426
NORBORANE, BROMO-
exo-, solvolysis of, deuterium isotope effects on, 20: 352
NERVE CELLS
radiation injuries of rat, pathology of, 20: 68
NERVOUS SYSTEM
radiation effects on development of, in rat embryos, 20: 60(R) (NYO-901-37, pp 33-68)
radiosensitivity of, biochemical exponents of, 20: 115
NEUTRINOS
interactions and properties of, (E/T), 20: 999
interactions with nucleons, SU(6) for N^* and Y_1^* production in, 20: 1020
motion in superdense matter, (T), 20: 951 (NP-15517)
NEUTRINOS (ν_μ)
interactions with protons, positron spectra from, (E), 20: 992 (COO-818-65)
interactions with protons, cross sections for, 20: 993 (COO-818-70)
reactions with deuterium, cross sections for, 20: 993 (COO-818-70)
NEUTRON-ABSORPTION ANALYSIS
use for determination of plutonium-239 in reactor fuels, 20: 233 (SGAE-PH-28/1965)
NEUTRON BEAMS
scattering by deuterium, polarization of recoil deuterons from, (T), 20: 997 (ORNL-P-1607)
NEUTRON CROSS SECTIONS
calculation for reactions (n,2n) on medium and heavy nuclei, method of, (T), 20: 1187
computer program for plotting differential, 20: 1149 (GAMD-6507)
data requests for, compilation of, 20: 1161 (WASH-1057)
NEUTRON DIFFRACTOMETERS
design of automatic double-crystal, engineering drawings for, 20: 675
NEUTRON FISSION CROSS SECTIONS
data evaluation, 20: 1160 (WAPD-T-1847)
NEUTRON PHOTOGRAPHY
film blackening in, methods for enhancing, 20: 667
use of gadolinium foil-photographic film combinations in, 20: 621 (LA-DC-6978)
NEUTRON SHIELDING
design for neutron sources, 20: 1323(P)
NEUTRON SOURCES
design of beryllium and lithium target, for use with high energy ion beams, 20: 1143(P)
development of tritium-target, 20: 696(R) (ORNL-3829)
shielding design for, 20: 1323(P)
use in control of soil irrigation, 20: 633
use in measuring soil moisture, 20: 632
NEUTRON SPECTRA
measurement in laminated iron–water, performance of threshold detectors for, 20: 1304 (AE-196)
measurement in reactors using threshold detectors, 20: 1414
NEUTRON SPECTROMETERS
design of polarization, for HFBRR, engineering drawings for, 20: 672
NEUTRONS
absorption by control rods, calculation method for resonance, 20: 1356
absorption in fuel rods, assembly for measuring cross sections for, 20: 1384(P)
capture by nuclei, gamma spectra from, 20: 1252
collision probabilities in cluster-type fuel elements, method of calculating, (T), 20: 1138
detection and measurement of, energy dependence of alanine dosimeter for, 20: 394
detection and measurement of, development of solid-state rate meter for, 20: 646 (AD-614432)
detection and measurement near reactors, monitor for, 20: 1362
detection of, miniature fission chambers for, 20: 680(P)
diffusion theory of, variational principles in, 20: 1136
diffusion theory parameters using bilinear averaging, multigroup,

20: 1140
dosimetry, role of momentum in, 20: 605
effects in barley seed, genetic, 20: 97
effects on aluminum–silicon alloys, recovery from, 20: 905
effects on bromobenzene temperature effect on, 20: 376
effects on carbohydrate and protein metabolism in brains, 20: 115
effects on copper, electron microscopy of defects from, 20: 906
effects on creep in type 304 stainless steel, 20: 889(R) (BNWL-120, pp 4.1-59)
effects on dislocation channeling in deformed rhenium, 20: 745(R) (BNWL-120, pp 3.1-22)
effects on ecology of bird populations of high-level, 20: 17
effects on EGCR prototype fuel elements, 20: 891 (GEAP-3893)
effects on lattice perturbations in semiconductors, 20: 908
effects on lithium fluoride thermal conductivity and lattice faults, (E), 20: 411
effects on pea seeds, genetic, 20: 81
effects on physical properties of graphite, 20: 756
effects on resistance of thin-film resistors, method for measuring, 20: 694
effects on silkworm eggs, lethal, 20: 72
effects on stainless steel-clad uranium mononitride, 20: 888 (BMI-1731)
effects on structure of molybdenum, combined effect of carbon impurity atoms on, 20: 895
effects on tensile properties of Hastelloy X-280, effects of cold working and aging on, 20: 889(R) (BNWL-120, pp 4.1-59)
energy spectra from (p,n) reactions on lanthanum, praseodymium, and tin at 6 to 14 Mev, (E/T), 20: 1239
flux density in reactors, instruments for measurement of, 20: 1359
flux distributions of, device for measuring, 20: 684(P)
interactions with protons at 630 Mev, phase shifts in, 20: 994 (JINR-P-2332)
interactions with mesons (K+) at 2.3 Bev/c, charge-exchange, (E), 20: 1009
interactions with mesons (K+) at 2.3 Bev/c, K* production in, (E), 20: 1010
kinetics in reactors, spatial and spectral coupling in, (T), 20: 1411 (CONF-650413-13)
photoproduction on carbon-12 to 52 Mev, cross sections for, (E), 20: 2296
photoproduction on lithium-6 at 5.7 to 32 Mev, cross sections for, (E), 20: 1217
reactions (n,α) and (n,p) with silicon-28 at 13.5 to 14.4 Mev, cross section for, (E), 20: 1163
reactions (n,t) with lithium-6, cross sections for, (T), 20: 1180
reactions (n,2n) with medium and heavy nuclei, cross sections for, (T), 20: 1187
reflection of, image source method for calculating, 20: 1061
resonance escape probability from cylinders, computer program for calculating, 20: 1133 (IDO-17075)
resonance integrals for uranium-238, methods for calculating, (T), 20: 1158 (ORNL-TM-1296)
resonance integrals for thorium dioxide and uranium carbide and dioxide, temperature-dependent, (T), 20: 1148 (CRRP-1222)
scattering by carbon, iron, and lithium-7 at 14.6 Mev, angular distributions, cross sections, and energy levels in inelastic, 20: 1144 (AD-614451)
scattering by magnesium-24 at 14 Mev, angular distributions for inelastic, 20: 1219
scattering in Maxwellian gases, average cosine for, (T), 20: 1135 (RT/FI(65)12)
shielding against, performance of lead-filled plastics for, 20: 1319
transport equation for, normal-mode solution of, 20: 1141
transport in one-dimensional rods, invariant-imbedding theory for, 20: 1315
transport in shielding materials, formulation of, (T), 20: 1303 (AD-614250)
transport theory for reactors, invariant-imbedding techniques in, 20: 1415
transport theory with anisotropic scattering, diffusion length in, 20: 1137

NEUTRONS, COLD
scattering by liquid methane, use of Langevin equation of Brownian motion for analysis of, 20: 313

NEUTRONS, DELAYED
model of, for reactor transfer functions, 20: 1356

NEUTRONS, EPITHERMAL
dosimetry in personnel using silver-activated phosphate glass, 20: 628

NEUTRONS, FAST
attenuation in air-filled annular ducts, method for prediction of, (T), 20: 1139
detection and measurement of, design of threshold detector for, 20: 681(P)
diffusion in laminated iron–water systems, (E/T), 20: 1304 (AE-196)
dosimetry of, using proton-recoil detectors, (T), 20: 654 (NP-15466)
dosimetry using sulfur disks, reduction of sulfur dose threshold in, 20: 647 (AERE-M-1631)
effects on anthracene oil and terphenyl mixture, 20: 356 (SGAE-CH-19/1965)
effects on dimensions of molybdenum, effects of carbon on, 20: 745(R) (BNWL-120, pp 3.1-22)
effects on dislocation channeling in molybdenum, effects of prestrain on, 20: 745(R) (BNWL-120, pp 3.1-22)
effects on ductility of types 304 and 348 stainless steel, 20: 889(R) (BNWL-120, pp 4.1-59)
effects on mechanical properties of Hastelloy X-280, Incoloy 800, Inconel 600, and INOR-8, 20: 889(R) (BNWL-120, pp 4.1-59)
effects on microstructure of high-purity iron, 20: 745(R) (BNWL-120, pp 3.1-22)
effects on plutonium dioxide–uranium dioxide fuel pins for fast reactors, transient, 20: 892 (GEAP-4804)
effects on reproductive capacity of flour beetles, *Tribolium castaneum*, 20: 84
effects on stress-rupture of Zircaloy-2, 20: 746(R) (BNWL-120, pp 6.1-11)
flux in annular ducts through laminated iron-heavy water shields, (E/T), 20: 1317
reactions (n,γ) with uranium-238 at 30 kev, gamma spectra from, (E), 20: 1168
reactions with uranium-235 and -238, fission ratios of, (E), 20: 1147 (CRRP-1220)
scattering by helium-4 at 10 to 700 Mev, polarization from, (E), 20: 1134 (ORNL-P-1604)
scattering in underground concrete structures, methods for calculating, (E/T), 20: 1307 (RRA-M45)
scattering in underground concrete structures, calculations for, (E/T), 20: 1308 (RRA-T41)
scattering in underground concrete and iron structures, methods for calculating, (E/T), 20: 1310 (RRA-T51)
slowing down in graphite and water without polarization loss, (T), 20: 1134 (ORNL-P-1604)
spectra in reactor shields of concrete and water, (E/T), 20: 1318
use in radiography, advantages of, 20: 667

NEUTRONS, PROMPT
detection probability of, Rossi-α experiment for, (T), 20: 1419

NEUTRONS, THERMAL
attenuation in air-filled annular ducts, method for prediction of, (T), 20: 1139
capture by americium-241, spontaneously fissioning americium-242 isomer from, (E), 20: 1191
dosimetry in personnel using silver-activated phosphate glass, 20: 628
effects on embrittlement of type 304 stainless steel, effects of boron on, 20: 898
flux in annular ducts through laminated iron-heavy water shields, (E/T), 20: 1317
leakage kernels and slowing down parameters of, errors in spatial harmonics for, (T), 20: 1142
reactions (n,γ) with iodine-127, spectra from, (E/T), 20: 1151 (IFA-RN-20)
reactions (n,γ) with mercury-199, gamma angular distributions from, (E), 20: 1152 (IFA-RN-21)
reactions (n,γ) with americium-241, americium-242 isomer production in, 20: 1155 (JINR-P-2347)
scattering by crystals, engineering drawings of diffractometer for studying, 20: 675
scattering by gaseous and liquid methanethiol and methanol, cross sections for, 20: 325
scattering by liquid methane, use of Langevin equation of Brownian motion for analysis of, 20: 313

NEVADA TEST SITE
geologic studies of Pre-Schooner sites in basalt in Buckboard Mesa, preshot, 20: 511 (PNE-505P)

NEW YORK
fallout monitoring in, New York Operations Office program for, 20: 521(R) (HASL-164)
radium-228 monitoring in foods at, 20: 148(R) (NYO-3086-1 Pt.IV)

NEW ZEALAND
fallout monitoring in, National Radiation Laboratory program for, 20: 521(R) (HASL-164)

NICKEL
anodic overvoltages of electrodes of, in molten fluorides, 20: 284 (EUR-804.e)
deposition on spherical particles of plutonium dioxide and plutonium dioxide–uranium dioxide, 20: 747 (EURAEC-1391)
determination as corrosion product in fuel solution of Berlin Research Reactor, 20: 1541
determination of traces of, in uranium using electron microprobe, 20: 225 (CONF-650810-2)
diffusion in chromium–nickel alloys, 20: 834(T) (AERE-Trans-1031)
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257

effects on isotopic exchange between cyclobutane and deuterium, 20: 304
proton total cross sections at 16.4 Mev, (E), 20: 1208
separation from cobalt and copper by extraction chromatography, 20: 433 (INP-412/C)
solubility in tungsten, effects of iron on, 20: 865
sorptive properties of annealed and oxidized single crystals of, for undecanoic and nonadecanoic acids, 20: 1570 (TID-22150)
vapor pressure, 20: 331
NICKEL ALLOY COUPLES
Alumel/Chromel, performance of thermocouples of, for PWR-1 seed 4 analysis, 20: 1477 (WAPR-PWR-TE-166)
NICKEL ALLOYS
oxidation by air and oxygen at 1120°C of Hastelloy X-280, 20: 762(R) (BNWL-120, pp 5.1-18)
radiation damage in Hastelloy X-280, effects of cold working and aging on neutron, 20: 889(R) (BNWL-120, pp 4.1-59)
radiation effects on mechanical properties of Hastelloy X-280, fast neutron, 20: 889(R) (BNWL-120, pp 4.1-59)
Cr–Ni, diffusion of chromium and nickel in, 20: 834(T) (AERE-Trans-1031)
Cr–Ni, thermodynamic properties, 20: 834(T) (AERE-Trans-1031)
Fe–Ni, structures in shock-loaded, deformation and transformation, 20: 817 (CONF-710)
Fe–Ni–W, diffusion in sintered, 20: 865
Mg–Ni, analysis for magnesium, electrographic, 20: 267
Ni–Pd, phase studies at 800 to 1400°C, 20: 338
Ni–Pt, phase studies at 800 to 1400°C, 20: 338
Ni–Zr, analysis for zirconium, electrographic, 20: 267
NICKEL CARBONYLS
complexes with cyclic phosphite esters, 20: 1561 (IS-T-31)
NICKEL COMPLEXES
with phosphoorganic compounds in TTA and 2,4-pentanediones, synergism in, 20: 261
NICKEL FLUORIDES
NiF_2–KF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
NICKEL ISOTOPES Ni-58
proton elastic scattering by, optical model parameters for distributions polarizations from, (E/T), 20: 1157 (ORNL-P-1616)
NICKEL ISOTOPES Ni-62
helium-3 reactions (He-3,d) at 22 Mev, (E), 20: 1216
NICKEL ISOTOPES Ni-64
helium-3 reactions (He-3,d) at 22 Mev, (E), 20: 1216
NICKEL OXIDES
radioinduced catalytic activity of, 20: 362
sintering of powders of, 20: 755(T) (IS-Trans-20)
MnO–NiO, phase studies at 800 to 1400°C, 20: 338
NiO–MgO, phase studies at 800 to 1400°C, 20: 338
NICKEL SYSTEMS
Al–Fe–Mg–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
C–Hf–Ni, phase studies of nickel-rich, 20: 826 (NP-15535)
C–Ni–Zr, phase studies of nickel-rich, 20: 826 (NP-15535)
NIOBIUM
analysis for tantalum by electron excitation, x-ray spectrographic, 20: 246
etching dislocations on oriented single-crystal faces of, 20: 866
mechanical properties of single crystal, effects of high vacuum purification on, 20: 838
melting of, composition of gases evolved during electron beam, 20: 872
separation from molybdenum, method for carrier-free, 20: 262
sorptive properties for nitrogen and oxygen at very low pressures, 20: 775(R) (SRIA-425-6, pp 10-33)
sorptive properties for oxygen, 20: 916(R) (SRIA-415-6)
superconducting penetration depth in, temperature variation of, (E), 20: 1131
thermodynamic properties of mixed state of superconducting, determination from magnetocaloric effects, 20: 1122
vapor pressure, 20: 331
welding, method for spot, 20: 789 (AD-619333)
NIOBIUM ALLOYS
critical temperature of superconducting transition metal-, 20: 1129
Ge–Nb, crystal structure of intermetallic compounds in, 20: 871
Mo–Nb–V–Zr, thermal properties to melting point, 20: 878
Nb–Sn, superconductivity of Nb_3Sn, (T), 20: 1264 (NBS-8843)
Nb–Ta–V, thermal properties to melting point, 20: 878
Nb–Ta–W–Zr, thermal properties to melting point, 20: 878
Nb–Ti–Zr, thermal properties to melting point, 20: 878
Nb–W–Zr, thermal properties to melting point, 20: 878
Nb–Zr, brittleness at −23 to 265°C, 20: 746(R) (BNWL-120, pp 6.1-11)
Nb–Zr, cavitation damage in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
Nb–Zr, corrosion by potassium at 2000°F, 20: 768(R) (NASA-CR-54226)
Nb–Zr, magnetic field effects on ultrasonic wave propagation in, 20: 863
Nb–Zr, magnetic flux annihilation and instabilities in inhomogeneous superconducting, (E), 20: 1132
Nb–Zr, performance in superconducting magnets, 20: 1120(R) (ORNL-3836, pp 90-110)
Nb–Zr, superconducting critical current density in, method for increasing, (E), 20: 1121(T) (AI-Trans-97)
NIOBIUM CARBIDES
extrusion of, development of techniques for, 20: 796
NIOBIUM ISOTOPES Nb-90
energy levels of, parity and spin of, (E), 20: 1159 (UCRL-16306)
isomeric transitions in, multipolarities of, (E), 20: 1159 (UCRL-16306)
NIOBIUM ISOTOPES Nb-93
photon reactions at 300 Mev peak, isomer production in, (E/T), 20: 1246
NIOBIUM NITRIDES
extrusion of, development of techniques for, 20: 796
NIOBIUM OXIDES
structure of Nb_6O, electron diffraction study on, 20: 876
$PbTiO_3$–$PbZrO_3$–Nb_2O_5, tensile strength of, 20: 828 (SC-DC-65-1588)
NIOBIUM SYSTEMS
C–Mo–Nb–Ta–W–Zr, erosion by sodium at 400, 1000, and 1500°F of Cb-132M, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–W–Zr, thermal properties to melting point, 20: 878
C–Nb–W–Y–Zr, corrosion by potassium at 2000°F of AS-55, 20: 768(R) (NASA-CR-54226)
C–Nb–W–Zr, corrosion by potassium at 2000°F of D-43, 20: 768(R) (NASA-CR-54226)
C–Nb–Zr, thermal properties to melting point, 20: 878
NITRATE IONS
lifetimes in ammonium nitrate solutions, determination from infrared and Raman spectra, 20: 324
spectra of, deuterium isotope effects on infrared, 20: 324
NITRIC ACID
diffusion of hafnium in, in ion exchange form, 20: 261
etching of uranium, effects on carbon and nitrogen analysis of, 20: 230 (NLCO-965, pp 4.1-5)
separation of metal ions from, by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
solvent partition between aqueous and organic phases of aliphatic amines in kerosene and xylene, 20: 223 (CEA-R-2760)
solvent properties for uranium, 20: 276(P)
use in dissolution of aluminum and aluminum–uranium alloy plates, 20: 438 (RT/CHX(65)23)
dichromate–nitric acid, corrosive effects on austenitic stainless steel, effects of steel composition on, 20: 767(R) (GEAP-4915)
methanol–HNO_3, use as eluant in separation of americium and curium by anion exchange, 20: 439(T) (ORNL-tr-893)
nitric acid–U–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
nitric acid–Pu–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
NITROGEN
determination in uranium, effects of nitric acid etching on, 20: 230 (NLCO-965, pp 4.1-5)
fission fragment energy loss in, 20: 387
plasma of, containment in DCX-2, 20: 1270(R) (ORNL-3836, pp 15-32)
radiation effects on diffusion in polyethylene, 20: 407
sorption by niobium at very low pressures, 20: 775(R) (SRIA-425-6, pp 10-33)
thermodynamic properties of, (T), 20: 1265 (NBS-3346)
yields in gamma radiolysis of aqueous potassium iodide-nitrous oxide solutions, 20: 392
yields in gamma radiolysis of aqueous nitrous oxide-sodium tellurite solutions, 20: 393
NITROGEN IONS
oxidation by peroxydisulfate ions in aqueous solution, kinetics of, 20: 1571(R) (TID-22186)
rotational temperatures in auroral atmosphere from 80 to 160 km, (E), 20: 1096
NITROGEN ISOTOPES N-14
deuteron reactions (d,α) at 24 Mev, energy spectra from, (E), 20: 1211
proton inelastic scattering at 19 Mev, (E), 20: 1183
proton reactions (p,2p) at 19 Mev, (E), 20: 1183
NITROGEN ISOTOPES N-15
use in study of fertilizer utilization by maize, 20: 9(R) (STI/DOC/10/42, pp 61-9)
NITROGEN MUSTARDS
toxicity of, in cats, rabbits, and rats, 20: 43
NITROGEN OXIDES
effects on radioinduced crosslinking of polyethylene, polypropylene, and ethylene-propylene copolymers, 20: 402

effects on radiolysis of cyclohexane vapor at 100°C, mechanism of, 20: 377
radiolysis of liquid nitrogen tetroxide, effects of nitric oxide and oxygen on yields in, 20: 380
yields in radiolysis of liquid nitrogen tetroxide, effects of nitric oxide and oxygen on yields in, 20: 380
KI–N_2O, yields in gamma radiolysis of aqueous solutions of, 20: 392
NONADECANOIC ACID
sorption by annealed and oxidized copper and nickel single crystals, 20: 1570 (TID-22150)
1-NONANOL
hexadecafluoro-, radiolysis of, ESR spectra of gamma, 20: 372
NOZZLES
plasma expansion in Laval, isentropic, (T), 20: 1295
stress concentration factor in spherical pressure vessels, 20: 1364
stress distribution in hemispherical pressure vessel with single radially attached, 20: 459 (ORNL-3817)
NPD REACTOR
design and performance, 20: 1485
electric system of, design review, 20: 1507
NUCLEAR EMULSIONS
meson (π^-) reactions at 7.2 Bev/c, meson (K) production in, 20: 1224
NUCLEAR ENGINEERING
engineering materials list, 20: 464 (TID-4100(Suppl.29))
NUCLEAR MAGNETIC MOMENTS
determination using optical double resonance, 20: 1237
NUCLEAR MAGNETIC RESONANCE
book: *Quantum Radiofrequency Physics*, 20: 925(T)
measurement of, techniques in, 20: 1166
NUCLEAR MATERIALS MANAGEMENT
analysis of fuels for plutonium-239 by neutron transmission measurements, 20: 233 (SGAE-PH-28/1965)
analysis of irradiated fuel elements for fission products by gamma spectrometry, 20: 236(T) (AEC-tr-6621)
determination of plutonium-239, uranium-233, and uranium-235 by fission counting, 20: 228 (LA-DC-7439)
safety control in chemical processing facilities of Savannah River Plant, 20: 431 (CONF-651103-7)
uranium distribution in solid homogeneous critical assembly fuel, method for measurement of, 20: 227 (KAPL-M-6448)
NUCLEAR MODELS
alpha reduced widths in superfluid, with projected wave functions, (T), 20: 1150 (IFA-FT-55)
nuclear structure in close-packed-spheron, (T), 20: 1218
NUCLEAR MODELS (SHELL)
energy level structure of nuclei with $29 \leq A \leq 40$, (T), 20: 1231
NUCLEAR PHYSICS
research on high energy report of Joint Committee on Atomic Energy on, 20: 1241
NUCLEAR POWER
development in Canada, future, 20: 1454 (AECL-2293)
development in Yugoslavia, 20: 1491
production of, classification and evaluation of, 20: 1494
NUCLEAR POWER PLANTS
accidents in, use of turbogenerator shut-down energy in, 20: 1492
cooling systems of, pressure control device for primary circuit of, 20: 1520(P)
design of steam generator for use in, 20: 1517(P)
design of Swiss NOK, 20: 1490
development and prospects of, review of, 20: 1481
development and utilization in Spain, 20: 1576
economic aspects of, in coordinated networks, 20: 1488
electric systems of foreign, 20: 1507
power conversion systems for lunar, 20: 1516
power failure or shut-down in pressurized water, emergency dynamic behavior in, 20: 1495
pressure vessels for British, construction and testing of prestressed concrete, 20: 1358
NUCLEAR REACTIONS
nucleon transfer strengths in, multipole sum rules for single, (T), 20: 1190
resonance width fluctuations in, Porter-Thomas distribution for, 20: 1188
theory of stripping, 20: 1228
use in determination of energy level structure of heavy nuclei, 20: 1229
use of two-nucleon-transfer, in nuclear structure analyses, (E/T), 20: 1232
NUCLEAR SPECTRA
measurement of, development of equipment for, 20: 1252
NUCLEAR STRUCTURE
analyses using electron linear accelerators, survey on, 20: 1233
analysis using two-nucleon-transfer reactions, (E/T), 20: 1232
model for, close-packed-spheron, (T), 20: 1218
theory of, group theory for, 20: 1236
NUCLEAR THEORY
use of group theory in, 20: 1236
NUCLEI
alpha decay of deformed, reduced widths in, (T), 20: 1150 (IFA-FT-55)
alpha elastic scattering by, distorted-wave model in, (E/T), 20: 1238
binding energy of 1p-shell, deformation effects in ground-state, (T), 20: 1170
decay of, angular correlations in, 20: 1166
deformation effects in 1p-shell nuclei, 20: 1170
deuteron elastic scattering by, distorted-wave model in, (E/T), 20: 1238
deuteron reactions (d,α) with, distorted-wave model in, (E/T), 20: 1238
deuteron scattering by non-spherical, analysis of diffractive, (T), 20: 1153 (INR-605/VII/PL)
electron elastic scattering by, cross sections for, 20: 1156 (JINR-P-2370)
electron scattering by, polarization effects in, (T), 20: 996 (NP-15204)
energy level excitation in, spectroscopic studies of, 20: 1252
energy level structure of heavy, determination using nuclear reactions, 20: 1229
energy level structure of $29 \leq A \leq 40$ in shell model, (T), 20: 1231
energy levels of deformed even-even, review on non-rotational collective, 20: 1165
energy levels of light, collective, (T), 20: 1227
energy levels of s-d shell, parity and spin determinations for, 20: 1230
magnetic fields of, para-, (T), 20: 1235
meson (μ^-) capture reactions with, elementary-particle model for, 20: 1207
meson (π^-) reactions at 7.2 Bev/c, meson (K) production in, 20: 1224
neutron capture by, gamma spectra from, 20: 1252
neutron cross sections for fissionable, evaluation of, 20: 1160 (WAPD-T-1847)
neutron reaction (n,2n) with medium and heavy, cross sections for, (T), 20: 1187
nucleon-nucleon interactions in, core polarization effects in two-body, (T), 20: 1186
photon reactions (γ,n) and (γ,p) with heavy, isospin selection rules in, (T), 20: 1226
proton reactions (p,2n) with vibrational, conversion electron spectra from, (E), 20: 1173
NUCLEIC ACIDS
radiation effects on metabolism of, in rat lens, tracer study, 20: 89
synthesis and storage of tritiated, 20: 2 (EUR-2419.1)
NUCLEONS
interactions with neutrinos, SU(6) for N^* and Y_1^* production in, 20: 1020
interactions with nucleons, two-meson (π) exchange contribution to phase shifts in, (T), 20: 1029
interactions with nucleons in nuclei, core polarization effects in two-body, (T), 20: 1186
structure of three-body systems of, electron scattering studies of, 20: 1234
transfer strengths in nuclear reactions, multipole sum rules for single, (T), 20: 1190
NUTRIENTS
effects on iodine-131 metabolism by cattle, 20: 598 (NP-15568)
leaching from plants of, during mist propagation, tracer study, 20: 21 (NYO-2598-25)

O

OATS
gamma attenuation coefficients for, (E/T), 20: 716
OILS
radioactive contamination of, 20: 152(R) (NYO-3086-1 Pt.VIII)
OPTICAL SYSTEMS
design for use with simulated radiation detectors, 20: 689(P)
use in electron polarization studies, 20: 959 (AD-613546)
use in study of phase boundaries, 20: 290 (UCRL-11997)
ORES
analysis for rhenium, activation, 20: 226 (IS-T-39)
ORGANIC COMPOUNDS
labeled, list of available, from Radiochemical Center, Amersham, Buckinghamshire, England, 20: 698
mechanical properties, effects of structure on, 20: 817 (CONF-710)
reactions of, tracer studies of mechanisms of, 20: 348
reactions with recoil carbon and tritium, 20: 359
ORGANIC COOLED REACTORS
cooling systems of, pressure control device for primary circuit of, 20: 1520(P)
design and performance of, for power production, 20: 1485
design of, without external shielding, 20: 1429(P)
ORGANIC MODERATED REACTORS
design and performance of, for power production, 20: 1485
design of, without external shielding, 20: 1429(P)

testing of, design of critical facility for, 20: 1413 (RT/ING(65)4)
ORGANISMS
radioinduced mutagenic chemicals in, effects of, 20: 106
OSCILLOGRAPHS
time delay channels for, engineering drawings of, 20: 639
OSKARSHAMN POWER REACTOR
electric system of, design review, 20: 1507
OSMIUM
vapor pressure, 20: 331
OSMIUM ALLOYS
Fe–Os, thermal capacity of, magnetic hyperfine, 20: 832 (UCRL-16180)
OSMIUM ISOTOPES Os-184
energy level structure, (E), 20: 1173
OSMIUM ISOTOPES Os-186
energy level structure, (E), 20: 1173
OVENS
development of plasma, 20: 1534(R) (LA-3370)
OXAZIRIDINE
2-*t*-butyl-3-*p*-nitrophenyl-, production by oxidation of Schiff base by peroxy acid, kinetics of, 20: 1571(R) (TID-22186)
OXIDES
reduction methods for purified isotopic target material, 20: 696(R) (ORNL-3829)
sintering of powder compacts of, 20: 755(T) (IS-Trans-20)
OXYGEN
content in liquid sodium, methods for controlling, 20: 1534(R) (LA-3370)
diffusion in grain boundaries of magnesium oxide, effects of iron on, 20: 830 (UCRL-14215)
effects of atmospheric, on radiosensitivity of *Serratia marcescens*, 20: 99
effects on anodic overvoltages of nickel electrodes in molten fluorides, 20: 284 (EUR-804.e)
effects on plutonium nitride crystal structure and sintered density, 20: 1534(R) (LA-3370)
effects on radiosensitivity of rat liver cells, 20: 95
effects on radiosensitivity of tumors, 20: 170
effects on yields in gamma radiolysis of liquid nitrogen tetroxide, 20: 380
electric discharge in, electron density and temperature in stratified low-pressure, (E), 20: 1086
electric discharge in, parameters for delayed glow anode region of, (E), 20: 1088
electron inelastic scattering by, fine structure of giant dipole resonance in, (E/T), 20: 1184
isotopic analysis by optical spectroscopy, 20: 269
oxidation of Hastelloy X-280 and Haynes 25 alloy at 1120°C, 20: 762(R) (BNWL-120, pp 5.1-18)
oxygen-18 exchange between alkali metal salts and gaseous, mechanism and rate of, 20: 422
polarography in molten alkali nitrates, oscillographic, 20: 285 (EUR-2496.e)
radiation effects on sulfuric acid oxidation by, dose rate effects on gamma and x-ray, 20: 412
reactions with neodymium and samarium, heats of reaction for, (E), 20: 757
reactions with plutonium, 20: 774 (RFP-609)
reactions with steels and metals, equilibrium pressures produced in, 20: 277 (AERE-R-4942)
sorption by niobium at very low pressures, 20: 775(R) (SRIA-425-6, pp 10-33)
sorption by niobium, 20: 916(R) (SRIA-425-6)
use in plutonium–uranium separation, 20: 456(P)
yields in gamma radiolysis of aqueous potassium iodide-nitrous oxide solutions, 20: 392
yields in gamma radiolysis of aqueous nitrous oxide-sodium tellurite solutions, 20: 393
OXYGEN IONS
polarography in molten alkali nitrates, oscillographic, 20: 285 (EUR-2496.e)
OXYGEN ISOTOPES O-15
energy levels, (T), 20: 1227
OXYGEN ISOTOPES O-16
deuterium reactions (d,α) at 24 Mev, energy spectra from, (E), 20: 1211
energy levels, (T), 20: 1227
proton inelastic scattering at 156 Mev, excitation of octupole and quadrupole levels in, (T), 20: 1215
OXYGEN ISOTOPES O-17
energy levels, (T), 20: 1227
energy levels from carbon-13 (α,α) and (α,n) reactions at 2 to 3.5 Mev, (E), 20: 1212
nuclear spin-spin splitting by chlorine in perchlorate ions, 20: 310
OXYGEN ISOTOPES O-18
content in surface and ground waters of karst region, Turkey, 20: 538
determination in carbon dioxide by mass spectrometric measurements, 20: 243
determination in gaseous oxygen by optical spectroscopy, 20: 269
energy levels, (T), 20: 1227
exchange between alkali metal salts and gaseous oxygen, mechanism and rate of, 20: 422
nucleon-nucleon interactions in, core polarization effects in two-body, (T), 20: 1186
OXYGEN SYSTEMS
ethane–O, radiation effects on production of ethyl hydroperoxide in, 20: 248
Fe–isobutylol–O–H_2SO_4–H_2O, radioinduced oxidation and reduction reactions of iron ions in, 20: 388
methane–O, radiation effects on production of methyl hydroperoxide in, 20: 248
W–O, phase studies and thermodynamic properties of, 20: 881
OYSTERS
zinc-65 content of Pacific Ocean, 20: 553 (BNWL-SA-293)

P

PACKAGE POWER REACTORS
design, 20: 1524(P)
PACKAGING
effects of polyethylene, on clostridium toxicity in irradiated fish, 20: 707
PAINTS
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
radiation effects on silicate base, electron and uv, 20: 910
sorptive properties for fission-product iodine from various environments, 20: 574 (CONF-650407, pp 730-46)
PAIR PRODUCTION
cross section of electron-positron, near threshold, (E), 20: 1214
PALLADIUM
diffusion of hydrogen and tritium in, tritium concentration by, 20: 272
effects on isotopic exchange between cyclobutane and deuterium, 20: 304
separation from nitric acid by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
vapor pressure, 20: 331
PALLADIUM ALLOYS
Co–Pd, phase studies at 800 to 1400°C, 20: 338
Cr–Pd, phase studies at 800 to 1400°C, 20: 338
Ni–Pd, phase studies at 800 to 1400°C, 20: 338
Pb–Pd, phase studies at 800 to 1400°C, 20: 338
Pd–Fe, phase studies at 800 to 1400°C, 20: 338
PALLADIUM ISOTOPES Pd-102
energy level structure, (E), 20: 1173
PAPER
radioisotope uses in industry of, 20: 706
PARASITES
radiation control of population of poultry, *Synagamus trachea*, 20: 70
PARTICLE TRACKS
analysis in wire spark chambers, resolution of ambiguities in, (E/T), 20: 650(R) (COO-614-37, Sect. 2C)
PARTICLES
collision model for, transport equations for multi-component assembly from BGK, 20: 1090
correlation functions in classical fluids, statistical mechanical expressions for, (T), 20: 1082 (COO-720-053)
filtration of micron and submicron, 20: 518
passage into diaphragmatic lymphatics of, from peritoneal cavity of mice, role of endothelial cells, 20: 16
removal from air–steam mixtures by steam suppression system, 20: 576 (CONF-650407, pp 776-804)
removal from gases, testing of high-efficiency filters for, 20: 577 (CONF-650407, pp 805-13)
size distribution of airborne heavy, measurement using cascade impactors, 20: 588 (CONF-650407, pp 1162-1203)
sorptive properties for radioiodine, 20: 216 (CONF-650407, pp 242-75)
PEACH BOTTOM POWER REACTOR
control rod cell analysis of, one- and two-dimensional, (T), 20: 1464 (GAMD-6364)
PEAS
mutations of, chemically induced, 20: 81
radioinduced mutations of, 20: 81
PEAT
sorptive properties for heavy radioactive cations from water, 20: 218(R) (ST1/DOC/10/42, pp 1-22)
PEBBLE BED REACTORS
safety of fast, 20: 1456 (BNL-9475)
2,4-PENTANEDIONE COMPLEXES
with metals and phosphoïrganic compounds, synergism in, 20: 261

2,4-PENTANEDIONE, HEXAFLUORO-
complexes with metals and phosphoörganic compounds, synergism in, 20: 261
2,4-PENTANEDIONE, TRIFLUORO-
complexes with metals and phosphoörganic compounds, synergism in, 20: 261
1-PENTANOL
octafluoro-, radiolysis of, ESR spectra of gamma, 20: 372
2-PENTANONE, 4-METHYL-
solvent properties for hafnium and zirconium, 20: 240
PEPTIDES
labeling with tritium, 20: 344 (EUR-1845.f)
PERCHLORATE IONS
oxygen-17 nuclear spin-spin splitting by chlorine in, 20: 310
PERCHLORIC ACID
diffusion of hafnium in, in ion exchange form, 20: 260
effects on disproportionation of uranium(V), kinetics of, 20: 328
oxidation and reduction of uranium ions in, disproportionation effects of organic acids on, 20: 326
solvent partition between aqueous and organic phases of aliphatic amines in kerosene and xylene, 20: 223 (CEA-R-2760)
PEROXYBENZOIC ACIDS
m-chloro-, reactions with Schiff base, kinetics of, 20: 1571(R) (TID-22186)
PEROXYDISULFATE IONS
reactions with ethanol, methanol, and nitrite ions, kinetics of, 20: 1571(R) (TID-22186)
PEROXYMONOSULFURIC ACID
reactions with chlorite ion in solution, kinetics, 20: 1571(R) (TID-22186)
PERSONNEL
health physics at Elk River Power Plant, 20: 1547 (CEND-512)
licensing and training of Saxton Reactor, 20: 1508
monitoring for alpha contamination, apparatus for, 20: 686(P)
radiation dosimetry with silver-activated phosphate glass, neutrons, 20: 628
radiation hazards from welding radiography, 20: 606
radiation monitoring in Hanford Laboratory, body counter for, 20: 660
radiation protection measures for Rocky Flats, following accidental plutonium releases, 20: 154 (RFP-621)
radiation protection of radiologists, 20: 188
radionuclide content and distribution in bones of radium dial painters, 20: 22(R) (NYO-3086-1 Pt.II)
radium-226 content in radium dial painters, whole-body, 20: 147(R) (NYO-3086-1 Pt.I)
training program at Netherlands Reactor Center, 20: 1352(T,R) (JPRS-31526)
PETROLEUM
radioisotope uses in industry of, 20: 706
PHARMACEUTICALS
preparation of labeled, 20: 200
radiosterilization of, stability of terpenes in, 20: 713
PHASE STUDIES
boundaries in, optical techniques for study of, 20: 290 (UCRL-11997)
PHENANTHRENEQUINONE IMINE
light effect on formation of 2-arylphenanthroxazoles from, 20: 397
radiolysis and photolysis of yields of 2-arylphenanthroxazoles from, 20: 397
PHENANTHROOXAZOLE, 2-ARYL-
light effects on formation of, from phenanthrenequinone, 20: 397
yields from radiolysis and photolysis of, phenanthrenequinone imine, 20: 397
PHENOL, DINITRO-
extraction from *Micrococcus radiodurans*, 20: 6(R) (NYO-3319-7)
PHENOTHIAZINE
effects on skin photosensitivity, uv, 20: 73
PHONONS
interactions with electrons in crystals containing defects, (T), 20: 1342
interactions with photons in semiconductors, 20: 1345
PHOSPHATE GLASS
silver-activated, neutron dosimetry in personnel using, 20: 628
PHOSPHATES
analysis of phosphorus-32-labeled, for radiochemical impurities, by chromatography, 20: 271
effects on strontium metabolism in animals, dietary, 20: 8(R) (STI/DOC/10/42, pp 23-43)
electronic structure of, 20: 232(R) (NYO-901-37, pp 80-4)
protective effects against gamma radiation in *Escherichia coli*, 20: 8(R) (STI/DOC/10/42, pp 23-43)
radiation effects on metabolism in carrot tissues and tomato stems, x, 20: 120
PHOSPHINE OXIDE, DIPHENYLVINYL
radioinduced polymerization of solid, mechanisms of, 20: 399
radioinduced polymerization of, effects of oxide powders on, 20: 408
PHOSPHINE OXIDE, TRIOCTYL-
complexes with metals in hexafluoroacetylacetone and TTA, synergism in, 20: 261
solvent properties for thorium, 20: 242
PHOSPHINE OXIDE, TRIPHENYL-
complexes with metals in acetylacetone and TTA, synergism in, 20: 261
PHOSPHINE SULFIDE, TRIOCTYL-
solvent properties for metal ions in hydrochloric and nitric acid solutions, 20: 244
PHOSPHITES
complexes of cyclic esters with metal carbonyls, 20: 1561 (IS-T-31)
PHOSPHONATES
ion exchange properties of Bio-Rex 63 resin for calcium, copper, thorium, and uranyl ions, 20: 263
PHOSPHONIC ACID, BUTYL, DIBUTYL ESTER
CCl_4–dibutyl butyl phosphonate, use in separation of americium from waste, 20: 436 (RL-SEP-518)
PHOSPHORIC ACID
solvent partition between aqueous and organic phases of aliphatic amines in kerosene and xylene, 20: 223 (CEA-R-2760)
PHOSPHORIC ACID, TRIBUTOXYETHYL ESTER
complexes with metals in TTA, synergism in, 20: 261
PHOSPHORODITHIOIC ACID
O,O-dimethyl-*S*-(methylcarbamoylmethyl) ester, preparation of tritium-labeled, 20: 423
PHOSPHORS
design of thin layered, for counting alpha particles, 20: 677(P)
excitation energy migration in molecular, (T), 20: 1325 (NP-15453)
radiation response of Conrad N, dose effects on, 20: 669
use in sandwiched rate meter detectors, 20: 646 (AD-614432)
use of thin plastic, for beta dosimetry, 20: 663
PHOSPHORUS ISOTOPES P-31
energy levels of, parity and spin determinations for, 20: 1230
gamma scattering from 7.14-Mev level of, (E), 20: 1203
PHOSPHORUS ISOTOPES P-32
analytical use for determination of zirconium as pyrophosphate, 20: 258
detection and measurement of, by 4π gas counter, 20: 666
effects on atherosclerosis development and lipid metabolism in pigeons, 20: 110
effects on polycythemia, therapeutic, 20: 189
incorporation in neutron-irradiated fertilizers, use of, 20: 699
use in diagnosis, 20: 207
use in study of fertilizer utilization by maize, 20: 9(R) (STI/DOC/10/42, pp 61-9)
PHOTOELECTRIC CELLS
use in sandwiched rate meter detectors, 20: 646 (AD-614432)
PHOTOELECTRIC EFFECT
cross sections for uranium from 0.01 to 2.00 Mev, (T), 20: 968
PHOTOGRAPHIC FILM
speeds of, for use with gadolinium foils in neutron radiography, 20: 621 (LA-DC-6978)
PHOTOGRAPHIC FILM DETECTORS
calibration of dosimeter, for gamma rays and thermal neutrons, 20: 648 (AERE-R-4960)
dose isodensity curves for, method for producing, 20: 671
energy-independent lead-frame and lead-lattice, design of, 20: 658
performance for neutron radiography, 20: 667
PHOTOMETERS
design of filter, for use in hot cells, engineering drawings for, 20: 275
PHOTOMETRY
nomenclature of units for, 20: 15
PHOTONS
emission in heavy particle-antiparticle annihilations, 20: 1024
emission of coherent, effects on stability of electron-beam spacecraft-propulsion systems, (T), 20: 499 (NP-15541)
gravitational effects on, Mössbauer measurement of, 20: 1114
interactions with deuterons at high energies, velocity-dependent potential in, (T), 20: 1195
interactions with phonons in semiconductors, 20: 1345
physical properties of, 20: 15
reactions (γ,n) and (γ,p) with heavy nuclei, isospin selection rules in, (T), 20: 1226
reactions in germanium, cross section for pair-production, (E), 20: 1214
theory of combinational and double processes of, 20: 1000
PHOTOSENSITIVITY
effects of drugs on skin, 20: 73
PHYSICS
book: *Conclusions of Mathematical Sciences*, Vol. 37, 20: 924
book: *Quantum Radiofrequency Physics*, 20: 925(T)
constants and conversion factors in, review of fundamental, (T), 20: 922

reduced matrix element of an irreducible spherical tensor operator for, derivation of, 20: 1329
time-reversal invariance in, violation of, 20: 918

PHYSIOLOGY
of adaptive enzyme changes, 20: 57(R) (NYO-901-37, pp 7-13)

PINCH EFFECT
plasma dynamics of deuterium in theta-, (E), 20: 1255 (ARL-65-171)
use for generating high-voltage pulses, 20: 1281(T) (AD-620824)

PIPES
fabrication of stainless steel-clad carbon steel, for La Crosse Boiling Water Reactor, 20: 788 (SWRI-1228-73)
fatigue strength of carbon steel, weld crack effects on, 20: 759
gamma transmission through walls of steel, thickness dependence of, (T), 20: 1320
heat transfer in two-phase flows in, 20: 483(R) (TID-22224)
neutron attenuation in air-filled annular, fast and thermal, (T), 20: 1139
openings in, stress analysis of reinforced, 20: 457(R) (BMI-X-276)

PLANETS
orbits of, relativity theory for perihelion precession of, 20: 1116

PLANT CELLS
radioinduced chromosome aberrations in trillium, effects of mitochondria on, 20: 71

PLANT METABOLISM
during mist propagation, tracer study, 20: 21 (NYO-2598-25)

PLANTS
cerium, iron, and manganese uptake by, 20: 19
cesium-137, potassium-40, radium-226, and strontium-90 contents in, in Australia, 20: 156
iodine-131 contamination of pasture, effects on content in milk, 20: 598 (NP-15568)
polonium-210 content of tobacco, 20: 158
propagation under mist, tracer study of nutrient leaching, 20: 21 (NYO-2598-25)
radiation effects on growth of *Vicia faba* roots, continuous low dose-rate x or gamma exposure, 20: 87
radioactivity of, in Alaska, 1959 to 1962, 20: 525

PLASMA
acceleration by electromagnetic wave, 20: 1291
acceleration in toroidal apparatus in electric fields, (E), 20: 1257 (IAE-769)
accelerator of argon, performance of coaxial, (E/T), 20: 1299
book: *Plasma Effects in Solids*, 20: 1346
containment and properties of, 20: 1273(R) (ORNL-3836, pp 81-9)
containment and stability in DCX-1, (E), 20: 1269(R) (ORNL-3836, pp 1-14)
containment in DCX-2, 20: 1270(R) (ORNL-3836, pp 15-32)
containment in rotating crossed fields, (E/T), 20: 1266 (NP-15450)
containment of, maximal ordering stability problem in, (T), 20: 1260 (MATT-370)
containment of, minimum-B magnet design for, (E), 20: 1279 (UCRL-14233)
development of thermonuclear, 20: 1268(R) (ORNL-3836)
diagnostics of lithium, methods for, (E/T), 20: 1534(R) (LA-3370)
diagnostics of, probe impedance in, (T), 20: 1253 (AFCRL-65-480)
electric conductivity of fully ionized, at high frequencies, (T), 20: 1300
electric currents in, analysis, (T), 20: 1262 (NASA-CR-309)
electromagnetic wave interactions in, 20: 1285
electromagnetic waves transformation in nonequilibrium, 20: 1286
electromagnetic wave propagation in cylindrical magnetic field, (T), 20: 1288
electron beam interactions with, amplification and stability in, (E/T), 20: 1261 (ML-1184)
electron beam interactions with magneto-, wave propagation from, (T), 20: 1267 (NYO-2813-34)
electron cyclotron harmonics from helium, line shape measurements for, (E), 20: 1258 (LA-DC-7364)
electron density and temperature in stratified low-pressure discharge, (E), 20: 1086
electron density of weakly ionized cesium, (E), 20: 1282
electron energy distribution in, second derivative methods for, 20: 1296
expansion in Laval nozzle, isentropic, (T), 20: 1295
flow in crossed electric and magnetic fields, one-dimensional, (T), 20: 1294
flow of expanded air, chemical and thermodynamic processes in inviscid nonequilibrium, (E/T), 20: 1297
heating by electron-cyclotron effects, in ELMO and EPA, 20: 1271(R) (ORNL-3826, pp 33-5)
interactions with ion beams, ion waves from, (T), 20: 1259 (MATT-366)
ion lifetime in octupole magnetic fields, (E), 20: 1256(R) (COO-1233-21)
ion waves in Q-3-T device, excitation by ion-beam–plasma interactions, (E), 20: 1259 (MATT-366)
ionization wave in discharge, forward-backward transition of, (E), 20: 1290
magnetic current sources in anisotropic compressible, dyadic Green's function for, (T), 20: 1283
microwave penetration through low-pressure, polarization modifications in, (E), 20: 1292
motion in octupole magnetic fields, (E), 20: 1256(R) (COO-1233-21)
oscillations in, electron and ion, (E), 20: 1254 (ARL-65-151)
pinch effect in, high-voltage pulses from, 20: 1281(T) (AD-620824)
production of highly ionized, in cesium hollow-cathode discharge, (E), 20: 1087
properties in calutrons, electric discharges, and mirror machines, (E), 20: 1272(R) (ORNL-3836, pp 36-66)
properties of deuterium, in theta-pinch devices, (E), 20: 1255 (ARL-65-171)
properties of oxygen glow discharge, in anode region, (E), 20: 1088
properties of solid-state, conference on, 20: 1346
stability of spatially inhomogeneous, Vlasov-Maxwell equations for low-frequency, (T), 20: 1301
stability of, effects of magnetic-field "line-tying" on, (T), 20: 1280 (UCRL-16055)
stability of, research on universal, (E), 20: 1278(R) (TID-22273)
thermal radiation of cylindrical, spectral power distribution of, 20: 1287
thermal radiation from, fluctuations of, (T), 20: 1293
thermonuclear reactions in, magnetic-field and temperature effects on, 20: 1275(R) (ORNL-3836, pp 117-19)
transport equation for model of, iteration procedure for, 20: 1302
velocity in free stream and in plasmatron nozzle, (E), 20: 501
wave propagation in bounded compressible, (T), 20: 1284
wave propagation in fully ionized, with uniform velocity, (T), 20: 1298

PLASMA JETS
development and efficiency for propulsion, (E), 20: 497(R) (AD-612175)
flow transitions in subsonic argon, (E), 20: 1084 (SU-247-9)
production and properties, (T), 20: 1262 (NASA-CR-309)
production of, device for, 20: 503(P)
properties of electric arc produced, 20: 1277 (TID-22136)
uses in chemistry and metallurgy, 20: 1277 (TID-22136)
velocity in plasmatron nozzle, 20: 501

PLASTIC-FILM DETECTORS
beta dosimetry using scintillating, 20: 663

PLASTICS
development of lead-filled, for reactor shielding, 20: 1319
heat transfer to laminar-flowing Bingham, in circular tube with internal heat generation, 20: 490
radiography of, scattering in fast neutron, 20: 667

PLATES
radiation transport in, formulation of, (T), 20: 1303 (AD-614250)

PLATINUM
content in teeth after use in dental restorations, 20: 27
effects on isotopic exchange between cyclobutane and deuterium, 20: 304
vapor pressure, 20: 331

PLATINUM ALLOYS
Co–Pt, phase studies at 800 to 1400°C, 20: 338
Cr–Pt, phase studies at 800 to 1400°C, 20: 338
Fe–Pt, phase studies at 800 to 1400°C, 20: 338
Fe–Pt, platinum-195 Mössbauer effect in absorbers of, (E), 20: 1202
Fe–Pt, thermal capacity of, magnetic hyperfine, 20: 832 (UCRL-16180)
Mn–Pt, phase studies at 800 to 1400°C, 20: 338
Ni–Pt, phase studies at 800 to 1400°C, 20: 338
Pb–Pt, phase studies at 800 to 1400°C, 20: 338

PLATINUM ISOTOPES Pt-190
energy level structure, (E), 20: 1173

PLATINUM ISOTOPES Pt-192
energy level structure, (E), 20: 1173

PLATINUM ISOTOPES Pt-195
energy levels of, magnetic moment of first-excited, (E), 20: 1202
Mössbauer effect in iron–platinum alloy absorbers, 20: 1202

PLOWSHARE PROJECT
chemical applications of nuclear explosions, research program on, 20: 469(R) (ORNL-TM-1275)
excavation of Isthmian sea-level canal by nuclear methods, general construction plan for, 20: 472 (PNE-2005)
excavation of Isthmian sea-level canal by nuclear methods, on-site survey program for, 20: 473 (PNE-2006)
excavation of Isthmian sea-level canal by nuclear methods, 20: 471 (PNE-1999)
Gasbuggy experiment on nuclear stimulation of natural gas reservoir, 20: 470 (PNE-1000)
Pre-Schooner sites in basalt, preshot studies of, 20: 511 (PNE-505P)
survey of, 20: 474

PLUTONIUM
accidental release of, contamination and hazards from, 20: 154 (RFP-621)
burnup of molten, design of experiment on, 20: 1534(R) (LA-3370)

crystal structure of, allotropic transformations in, 20: 1534(R) (LA-3370)
determination in plutonium oxide, calorimetric, 20: 259
determination of, by automated potentiometric titration, 20: 222 (AERE-R-4975)
economics of, as fuel in water moderated reactors, (T), 20: 1436 (GEAP-4907)
etching of, electrolytic swab technique for, 20: 751 (RFP-543)
excretion, effects of diethylenetriaminepentaacetic acid treatment, 20: 24 (RFP-640)
extrusion of fine wire of, hot, 20: 787 (RFP-623)
oxidation by air and oxygen at temperatures to 450°C, 20: 774 (RFP-609)
phase transformations in, effects of prior deformation on, 20: 745(R) (BNWL-120, pp 3.1-22)
phase transformation of, equilibrium temperature of alpha–beta, 20: 822 (LA-DC-7278)
preparation of high-purity, by Lamex process, 20: 443
processing of irradiated fuels containing, 20: 455(P)
recovery from analytical laboratory wastes, 20: 435 (RFP-551)
refining process for, electro-, 20: 752(R) (RL-SEP-503)
removal from copper and brass, ultrasonic, 20: 430 (CEA-R-2823)
separation from americium by extraction chromatography, 20: 433 (INP-412/C)
separation from metallic impurities by electrorefining in fused salt, Lamex process for, 20: 443
separation from thorium by ion exchange followed by solvent extraction using trioctyl phosphine oxide, 20: 242
separation from uranium by solvent extraction using secondary and quaternary ammonium nitrates, 20: 437 (RT/CHI(65)21)
separation from uranium by selective hexafluoride reduction, 20: 445
separation from uranium by solvent extraction using cadmium–magnesium–zinc melt, 20: 447
separation from uranium, electrolytic method for, 20: 456(P)
solvent properties for carbon, rhenium, tantalum, and tungsten at 700 to 950°C, 20: 1534(R) (LA-3370)
use in European power reactors, 20: 1463 (EUR-2445.f)

PLUTONIUM ALLOYS
determination in reactor fuels, destructive, 20: 234(R) (STI/DOC/10/42, pp 57-8)
Am–Pu, separation of plutonium from, by Lamex process, 20: 443
Ce–Co–Pu, diffusion through fuel can fission-gas vents, mechanisms of, 20: 1534(R) (LA-3370)
Ce–Co–Pu, reactions with tantalum at high temperatures, 20: 1534(R) (LA-3370)
Ce–Co–Pu, segregation by solidification, effects on reactivity of, 20: 1534(R) (LA-3370)
Fe–Pu, separation of plutonium from, by Lamex process, 20: 443
Ga–Pu, fatigue behavior of delta-stabilized, effects of metallurgical condition on, 20: 816 (BNWL-SA-210)
Ga–Pu, phase transformation of cored and homogenized, pressure-induced delta–alpha, 20: 815 (BNWL-SA-209)
Ga–Pu, properties of, 20: 815 (BNWL-SA-209)
Ga–Pu, separation of plutonium from, by Lamex process, 20: 443
Pu–Sc, crystal structure and phases of, 20: 1534(R) (LA-3370)
Pu–Th, separation of plutonium from, by Lamex process, 20: 443
Pu–U, separation of plutonium from, by Lamex process, 20: 443

PLUTONIUM CARBIDES
fabrication of spherical particles of, by powder agglomeration method, 20: 793
thermodynamic properties and vapor pressures of, 20: 1534(R) (LA-3370)
C–PuC, analysis of cermets of, for plutonium, 20: 222 (AERE-R-4975)

PLUTONIUM CHLORIDES
Pu_2C_3–U_2C_3, crystal structure, 20: 1534(R) (LA-3370)

PLUTONIUM(IV) FLUORIDES
oxidation of, equipment and methods for production of plutonium hexafluoride by, 20: 432(R) (EURAEC-1402)

PLUTONIUM(VI) FLUORIDES
production from plutonium tetrafluoride, equipment and methods for, 20: 432(R) (EURAEC-1402)
reactions with freons, hydrogen, and sulfur dioxide, 20: 445

PLUTONIUM ISOTOPES Pu-238
contamination from SNAP-9A, 20: 521(R) (HASL-164)
content in SNAP-9A, 20: 521(R) (HASL-164)
use in SNAP-15A, safety criteria for, 20: 722 (GA-4554(Rev.))

PLUTONIUM ISOTOPES Pu-239
determination in reactor fuels by neutron transmission measurements, 20: 233 (SGAE-PH-28/1965)
determination of, fission-counting technique for, 20: 228 (LA-DC-7439)
distribution from nuclear excavation in basalt, 20: 613
effects on bones in mice, pathological, 20: 60(R) (NYO-901-37, pp 33-68)
effects on serum lactic dehydrogenase levels in beagles, by internal deposition, 20: 112
half life and power output of, (E), 20: 259
neutron capture and fission constants for, survey on, 20: 1164
use in fission chambers, 20: 696(R) (ORNL-3829)

PLUTONIUM ISOTOPES Pu-241
neutron capture and fission constants for, survey on, 20: 1164

PLUTONIUM(IV) NITRATES
criticality data for solutions of, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))

PLUTONIUM NITRIDES
crystal structure and sintered density of, effects of oxygen on, 20: 1534(R) (LA-3370)

PLUTONIUM OXALATES
plutonium oxalate–H_2O, criticality data, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))

PLUTONIUM OXIDES
fabrication of spherical particles of, by powder agglomeration method, 20: 793

PLUTONIUM(IV) OXIDES
analysis for plutonium, calorimetric, 20: 259
fluorination using chlorine trifluoride, 20: 432(R) (EURAEC-1402)
preparation of coated spherical particles of, 20: 747 (EURAEC-1391)
PuO_2–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1 (1st.Rev.))
PuO_2–stainless steel–UO_2, analysis of cermets of, for plutonium, 20: 222 (AERE-R-4975)
PuO_2–UO_2, performance as fuels in water moderated reactors, (T), 20: 1436 (GEAP-4907)
PuO_2–UO_2, preparation of coated spherical particles of, 20: 747 (EURAEC-1391)
PuO_2–UO_2, reactivity calculations for use in EBWR, 20: 1457 (BNWL-126)
PuO_2–UO_2–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))

PLUTONIUM POISONING
therapy using diethylenetriaminepentaacetic acid, 20: 24 (RFP-640)
therapy using diethylenetriaminepentaacetic acid, in mice, 20: 60(R) (NYO-901-37, pp 33-68)

PLUTONIUM RECYCLE TEST REACTOR
corrosion of Zircaloy-2 in, 20: 764 (BNWL-SA-313)
design and operation, 20: 1458 (BNWL-SA-308)
performance characteristics of, 20: 1356
pressure tube fretting corrosion in, causes and minimization of, 20: 1367

PLUTONIUM SYSTEMS
nitric acid–Pu–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
Pu–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))

POLAND
radioisotope uses in, industrial, 20: 705

POLAROGRAPHY
biological applications of, 20: 44 (COO-1148-98)

POLONIUM
vapor pressure, 20: 331

POLONIUM ISOTOPES Po-210
alpha decay product ions in surface deposits of, energy loss and charge of, (E), 20: 426
content in tobacco smoke from cigarettes, 20: 158

POLYCYTHEMIA
radiotherapy using phosphorus-32, 20: 189
tracer study of high-altitude-induced, 20: 163(R) (STI/DOC/10/42, pp 71-127)

POLYMERIZATION
mechanisms of, cationic and radical, 20: 383
radioinduced, of compressed particulate trioxane, 20: 415(P)

POLYMERS
aqueous solutions of, radiation effects on, protective effects of colloidal sulfur, tracer study, 20: 137
light scattering by films of, polarization effects in, (T), 20: 1572 (TID-22196)
radiation effects on diffusion of gases in, 20: 407

POLYOXYMETHYLENES
synthesis by radioinduced polymerization of compressed particulate trioxane, 20: 415(P)

POLYPHOSPHATES
protective effects against gamma radiation in *Escherichia coli*, 20: 8(R) (STI/DOC/10/42, pp 23-43)

POPULATIONS
fallout effects in Marshall Islands, medical findings ten years post-exposure, 20: 90
radiation control of poultry parasite, *Syngamus trachea*, 20: 70
radiation control of navel orangeworm, *Paramyelois transitella*, 20: 83
radiation dose to EURATOM, from contaminated food and milk, 1963, 20: 144 (EUR-2460.d,f,i,n)

radiation effects on ecology of bird, 20: 17
radium-228 content in diet of human, 20: 148(R) (NYO-3086-1 Pt.IV)
PORES
size of barrier or filter, determination of, 20: 728(P)
POROSITY
measurement in radioactive samples, equipment for, 20: 622 (LA-DC-7149)
POSITRONS
interactions with electrons, polarization effects in, (T), 20: 996 (NP-15204)
interactions with electrons via W bosons, differential cross section for, (T), 20: 1018
lifetime in irradiated polyethylene, 20: 1002
magnetic moment of, g-factor determination for, (E), 20: 998 (TID-22255)
production in antineutrino interactions with protons, spectra of, (E), 20: 992 (COO-818-65)
scattering by bismuth at 150 and 300 Mev, cross sections for, (E), 20: 913 (LAL-1142)
POTASSIUM
boiling of, superheat in, 20: 482 (ORNL-P-1659)
content in chondrites and chondrules, age estimation from, 20: 529
corrosive effects on niobium-base alloys at 2000°F, 20: 768(R) (NASA-CR-54226)
thermodynamic properties of, at high temperatures, 20: 286 (NRL-6233)
POTASSIUM ACID FLUORIDES
properties for use as fusing agent for decomposition of thorium ore, 20: 333
POTASSIUM ALLOYS
K–Na, corrosive effects on reactor cooling system materials, 20: 773(R) (ORNL-3859)
K–Na, corrosive effects on boron carbide/stainless steel at 1000°F, 20: 776 (TIM-822)
POTASSIUM BROMIDES
radioinduced F centers at room temperature in crystals of, x, 20: 46 (PRNC-40)
KBr–LiBr, isotope shift of lithium resonant mode in, (E), 20: 1339
POTASSIUM CHLORATES
determination in mixtures with antimony sulfide in ignitor beads, atomic absorption spectrophotometric, 20: 229 (MLM-1289J)
POTASSIUM CHLORIDES
crystal growth studies of, (E), 20: 287 (ORNL-P-1611)
effects on radioinduced changes in proteins, 20: 49
ion self-diffusion mobilities in, determination from tracer transfer rate coefficients, 20: 425
lifetime of excited F-center in, (T), 20: 1342
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
radioinduced F centers and luminescence in, x, 20: 903
use in plutonium–uranium separation, 20: 456(P)
KCl–UCl_3, preparation for testing as reactor blanket, 20: 1534(R) (LA-3370)
LiCl–KCl, chlorination of uranium tetrachloride in fused, 20: 292 (UCRL-16173)
POTASSIUM CHROMATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
POTASSIUM FLUORIDES
AlF_3–KF–ZrF_4, uses of fused, in fluoride volatility process for separation of uranium from spent fuel elements, 20: 442
KF–NaF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
LiF–KF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
LiF–KF–NaF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
NiF_2–KF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
POTASSIUM IODIDES
diffusion of argon from, 20: 1324(R) (EURAEC-1428)
reactions with mixtures of alkyl peroxides and hydrogen peroxide, iodometric analysis of, 20: 248
KI–N_2O, yields in gamma radiolysis of aqueous solutions of, 20: 392
POTASSIUM ISOTOPES K-40
content in igneous and metamorphic rocks, Llano Uplift, Texas, 20: 532
content in natural and processed materials in Australia, 20: 156
POTASSIUM ISOTOPES K-42
exchange in potassium chloride solutions, rate coefficients for, 20: 425
POTASSIUM NITRATES
KNO_3–$NaNO_3$, polarography of oxygen and hydroxyl ions in molten, oscillographic, 20: 285 (EUR-2496.e)
$LiNO_3$–KNO_3–$NaNO_3$, polarography of oxygen and hydroxyl ions in molten, oscillographic, 20: 285 (EUR-2496.e)
POTASSIUM PERCHLORATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
POTASSIUM PHOSPHATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
POTASSIUM SULFATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
POTATOES
radiation processing of, effects on storage life, 20: 701 (COO-1283-27)
POWDER COMPACTS
design of differential thermal expansion die for producing cylindrical, 20: 781 (AI-65-12)
POWDERS
sintering of compacts of oxide, 20: 755(T) (IS-Trans-20)
POWER CYCLES
performance of Brayton and Rankine, for lunar nuclear power plants, 20: 1516
POWER PLANTS
design of coal-driven, 20: 610
radioactive effluents from fossil-fuel, effects on atmospheric contamination, 20: 152(R) (NYO-3086-1 Pt.VIII)
POWER REACTORS
accident analysis, calculation of radioactivity release in loss-of-coolant, 20: 583 (CONF-650407, pp 970-83)
design and performance of boiling-water, 20: 1484
design and performance of heavy water and organic, 20: 1485
design concept improvements for, 20: 1486
design development of fast, 20: 1487
design development for CIRENE, 20: 1489
design of gas-cooled, with superheater, 20: 1518(P)
design of portable, 20: 1422
design of Russian, 20: 1351 (WASH-1060)
design of Swiss NOK, 20: 1490
design of, review of, 20: 1422
design of, with inner matrix of stacked corrugated beryllium or beryllium oxide sheets, 20: 1521(P)
development and performance of gas-cooled graphite-moderated, in England and France, 20: 1482
development and performance of pressurized-water, 20: 1483
development and principles of graphite-moderated pressure-tube, 20: 1493
development in Europe, evaluation of future, 20: 1469 (KFK-359)
development of, review of, 20: 1481
fission product release from accidents in, safety program on, 20: 571 (CONF-650407, pp 641-7)
fuel development for European fast, 20: 1463 (EUR-2445.f)
fuel element design for PRO, instrumented, 20: 1473 (RT/ING(64)12bis)
fuel elements for PRO, development of instrumented, 20: 1472 (RT/ING(64)-12)
licensing of U. S., changes in regulations for, 20: 1510
regulatory review of U. S., action on, 20: 1509
safeguards in, engineered, 20: 586 (CONF-650407, pp 1071-9)
safety analysis of, probabilistic methodology for, 20: 1461 (CONF-650407, pp 1035-56)
safety evaluation of, maximum credible accident concept in, 20: 580 (CONF-650407, pp 908-20)
safety of large, containment and siting requirements in, 20: 1460 (CONF-650407, pp 1015-34)
sites for, criteria of, 20: 541
stability of, analog studies, 20: 1474(R) (STI/DOC/10/42, pp 59-60)
POWER SUPPLIES
development for Brookhaven AGS magnets, 20: 928 (BNL-9500)
PRASEODYMIUM
determination of, in rare-earth mixtures, photometric, 20: 252
energy levels of, lifetime of, (E), 20: 1175
ionization and oxidation on rhenium and tungsten in oxygen atmosphere, 20: 757
proton reactions (p,n) at 6 to 14 Mev, neutron spectra from, (E/T), 20: 1239
PRASEODYMIUM ALLOYS
Pr–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Sb–Pr, magnetic properties, 20: 309
PRASEODYMIUM ARSENIDES
magnetic properties, 20: 309
PRASEODYMIUM CHLORIDES
preparation of alcoholates, 20: 316
PRASEODYMIUM ISOTOPES Pr-143
energy levels from cerium-143 decay, (E), 20: 1199
PRASEODYMIUM ISOTOPES Pr-144
decay of, contribution to total beta activity of coastal sediments of Ligurian Sea from, 20: 526
determination in irradiated fuel elements by gamma spectrometry, 20: 236(T) (AEC-tr-6621)
separation from cerium-144, solvent extraction, 20: 444

PRASEODYMIUM NIOBATES
preparation and structure of perovskite type, 20: 844
PRASEODYMIUM OXIDES
$BaO-Pr_2O_3$, phase studies, 20: 302
Pr_2O_3-SrO, phase studies, 20: 302
PRASEODYMIUM PHOSPHIDES
magnetic properties, 20: 309
PRASEODYMIUM SELENIDES
electric properties, 20: 868
PRASEODYMIUM TANTALATES
preparation and structure of perovskite type, 20: 844
PRECIPITATION, ATMOSPHERIC
radioactivity of, in Canada, 1965, 20: 596 (NP-15542)
radioactivity of, in Canada, 1965, 20: 597 (NP-15563)
PREGNANCY
radiation hazards from diagnostic radiography during, 20: 187
radiation hazards of diagnostic radiography during, 20: 195
radiation hazards of diagnostic radiography during, 20: 214
radiographic pelvimetry during, 20: 187
radiotherapy during, 20: 199
radiotherapy of cervical carcinoma during, 20: 201
radiotherapy of Hodgkin's disease during, 20: 209
PRESSURE DROP
prediction of two-phase, correlation for, 20: 491
PRESSURE VESSELS
collapse pressure for cylindrical-spherical, 20: 465
design for Chinon Reactor (EDF-1), 20: 1479
design for gas-cooled reactors, 20: 1381(P)
design, construction, and testing of prestressed concrete, for British nuclear power plants, 20: 1358
fabrication of, quality control and nondestructive testing in, 20: 1366
fission product escape from containment systems, analysis, 20: 587 (CONF-650407, pp 1080-90)
fission product release from double containment system, calculation of, 20: 584 (CONF-650407, pp 984-99)
fission product transport in pressure suppression containment after loss-of-coolant accident, 20: 575 (CONF-650407, pp 753-75)
materials for, transformations and microstructure of A302B steel, 20: 833 (WERL-8844-5)
openings in, stress analysis of reinforced, 20: 457(R) (BMI-X-276)
pipe penetrations of prestressed concrete, 20: 1387(P)
seals for, design of mechanical coupling, 20: 1374(P)
stress concentration factor of nozzles in spherical, 20: 1364
stress concentrations in nozzle ring of, 20: 1365
stress distribution in hemispherical, with single radially attached nozzle, 20: 459 (ORNL-3817)
PRESSURIZED WATER REACTORS
accident analysis in, program for evaluation of data for blowdown, 20: 570 (CONF-650407, pp 609-40)
accidents in, use of turbogenerator shut-down energy in, 20: 1492
design of Russian, 20: 1351 (WASH-1060)
design of, for power production, 20: 1486
development of, for power production, 20: 1483
power failure or shut-down in, emergency dynamic behavior in, 20: 1495
PROCESS HEAT REACTORS
design of heterogeneous, for insertion into bituminous deposits in bore holes, 20: 1526(P)
design of, review of, 20: 1422
PROMETHIUM
purification by ion exchange, evaluation of eluting agents in, 20: 429 (BNWL-69)
PROMETHIUM ISOTOPES Pm-147
decay of, contribution to total beta activity of coastal sediments of Ligurian Sea from, 20: 526
separation from radioactive wastes, plant-scale demonstration of processes for, 20: 1551 (RL-SA-53)
PROMETHIUM ISOTOPES Pm-148
energy levels of, hyperfine structure and nuclear moments and spins of, (E), 20: 1248
PROPANE
electron inelastic scattering by, energy distribution and total cross sections for, 20: 335
radiolysis of, effects of temperature on hydrogen yields in, 20: 381
PROPANE, 1-CHLORO-2-METHYL-
photoinduced chlorination, 20: 347(R) (TID-22251)
PROPANE, 2,2-DIMETHYL-
radiolysis of gas-phase, electron and uv, 20: 369
PROPANE, 2-METHYL-
photoinduced chlorination, 20: 347(R) (TID-22251)
radioinduced reactions with ethylene and propene at high pressure and temperature, beta, 20: 355(R) (NYO-2978-42)
2-PROPANOL
reactions with anhydrous praseodymium and neodymium chlorides to form alcoholates, 20: 316
1-PROPANOL, 2-METHYL-
Fe–isobutylol–O–H_2SO_4–H_2O, radioinduced oxidation and reduction reactions of iron ions in, 20: 388
PROPELLANTS
level indication of, in spacecraft, use of krypton-85 for, 20: 721
PROPENE
effects on radiolysis of cyclohexane vapor at 100°C, mechanism of, 20: 377
radioinduced alkylation with isobutane at high pressure and temperature, beta, 20: 355(R) (NYO-2978-42)
PROPENE, 2-METHYL-
radioinduced polymerization with methyl methacrylate, 20: 367
radioinduced polymerization with vinylidene chloride at 0, –38, and –78°C, effects of zinc oxide on, 20: 403
radioinduced polymerization of, at –78°C, effects of solid additives on, 20: 403
radioinduced polymerization of, effects of various organic solvents on gamma, 20: 409
PROPENE, 2-METHYL- POLYMERS
properties and stability of, for use as gamma and proton detectors, 20: 391
PROPENE POLYMERS
radioinduced crosslinking of, effect of nitrous oxide on, 20: 402
with ethylene radioinduced crosslinking of, effects of nitrous oxide on, 20: 402
with propylene, radioinduced polymerization with methyl methacrylate, 20: 367
PROPORTIONAL DETECTORS
design of flow, engineering drawings for, 20: 674
performance of 4π gas, for beta and beta-gamma emitters, 20: 666
uses for gamma detection in radiometric level gages for glass furnaces, 20: 714
PROPULSION
development of gamma radioisotope thrustor for, 20: 724
electron-beam, effects of coherent radiation on stability of, for space vehicles, (T), 20: 499 (NP-15541)
ion-beam, development of 15-mlb-thrust engines for, (E), 20: 498 (NASA-CR-54136)
ion, performance of liquid-protected electrodes in, 20: 502
plasma jets for, production of, 20: 503(P)
plasma-jet engine for space, efficiency of, 20: 497(R) (AD-612175)
plasma-jet engines for space, performance of, 20: 500
PROTEINS
crystal structure of powdered, x-ray diffraction study, 20: 232(R) (NYO-901-37, pp 80-4)
deuterium–hydrogen exchange in muscle, 20: 349
deuterium–hydrogen exchange in, 20: 419
labeling with tritium, 20: 344 (EUR-1845.f)
radiation effects on solutions of, in presence of inorganic ions, 20: 49
radiation effects on lens crystallin, γ, 20: 67
radiation effects on metabolism in brain, gamma and neutron, 20: 115
PROTON PAIRS
annihilation of, photon emission in, 20: 1024
PROTONS
acceleration in standing-wave linacs, normal-mode analysis of, (T), 20: 929 (BNL-9514)
angular correlations with gamma rays in carbon-12 (d,p) reactions at 2 to 3 Mev, (E), 20: 1242
angular distributions from aluminum-27 and silicon-28 (d,p) reactions at 1.7 to 3.7 Mev, (E), 20: 1244
detection and measurement of, stability of polyacrylamide and polyisobutylene for, 20: 391
detection and measurement of, energy dependence of alanine dosimeter for, 20: 394
effects on copper, stage III annealing of, 20: 902
effects on electric conductivity of gold, 20: 909
effects on ribonuclease, maximum permissible dose from, 20: 107
energy losses in single crystals of silicon, axial and planar effects in, (E), 20: 1334
energy losses in thin foils, (E), 20: 969
exchange with deuterons in radical of irradiated single crystals of aspartic acid, (E), 20: 373
interactions at 9 Bev, secondary-particle angular distributions from, (E), 20: 984 (IAE-574)
interactions with antineutrinos, positron spectra from, (E), 20: 992 (COO-818-65)
interactions with antineutrinos, cross sections for, 20: 993 (COO-818-70)
interactions with mesons ($\pi^{\pm}$) at 3.7 Bev/c, diffraction scattering effects in, (E), 20: 1008
interactions with mesons (K^+) at 2.3 Bev/c, K^* production in, (E),

20: 1010
interactions with mesons (K^-), decay-hyperon (Λ^0) polarization in ($\pi^0\Sigma^0$), (T), 20: 1013
interactions with mesons (K^-) and (π^-), SU(6) model for cross sections for, 20: 1017
interactions with gamma rays, dispersion relations for Compton, (T), 20: 1026
interactions with mesons (π^+) at 1.2 Bev/c, meson (η^0) production in, (E), 20: 1027
interactions with protons at 11.6 to 22.9 Bev/c, transverse momentum distributions in (π^+d), (E/T), 20: 1031
interactions with antiprotons in flight, review of, 20: 1052
interactions with mesons (π), sum rules for partially conserved axial vector current in, 20: 1066
interactions with neutrons at 630 Mev, phase shifts in, 20: 994 (JINR-P-2332)
interactions with mesons (π^+) at 2.77 Bev/c, double resonance production in, (E), 20: 1019
momentum/velocity ratio of fast, relativity-theory tests by, (E), 20: 1117
reactions (p,nγ) ($n \geq 2$) with sulfur-34, correlations from, 20: 1146 (COO-1120-38)
reactions (p,n) with nuclei at 370 Mev, nuclear-structure effects in, (E/T), 20: 1213
reactions (p,n) with lanthanum, praseodymium, and tin at 6 to 14 Mev, spectra from, (E/T), 20: 1239
reactions (p,2p) with nitrogen-14 at 19 Mev, (E), 20: 1183
reactions with hydrogen at 1.30 to 150 kev, resonant electron capture in, 20: 971
reactions with nuclei at 16.4 Mev, total cross sections for, (E), 20: 1208
reactions with rare gases at 1 to 23 kev, metastable 2S hydrogen atom production in, (E), 20: 982
reactions with tantalum at 660 Mev, gadolinium-149 production in, (E), 20: 1220
reactions with uranium-238 at 7 to 12 Mev, charge and mass distributions from fission, (E/T), 20: 1247
scattering by aluminum-27 and magnesium-25 at 17.5 Mev, coupling effects in, 20: 1192
scattering by calcium-40, carbon-12, and oxygen-16 at 156-Mev, level excitation in, (T), 20: 1215
scattering by helium-4 at 40 Mev, inelastic, (E), 20: 1232
scattering by nitrogen-14 at 19 Mev, inelastic, (E), 20: 1183
scattering by nuclei, optical model parameters for distributions and polarizations from elastic, (E/T), 20: 1157 (ORNL-P-1616)
spectra from deuteron reactions with deuterium at 25.3 Mev, (E), 20: 1172
transfer in aqueous solutions and biological systems, Grotthuss mechanisms in, 20: 340

PROTOZOA
radioinduced inactivation of green colony formation in *Euglena gracilis*, uv, 20: 129

PSEUDOUREA, 2-(2-AMINOETHYL)-2-THIO-
cysteine–AET, protective effects against radiation effects in monkeys, 20: 140
effects on mitotic index in rat bone marrow, 20: 143
radiosensitivity effects on adrenal gland function in rats, 20: 141
radiosensitivity effects on rats, gamma, 20: 143

PSYCHOLOGY
radiation effects on learning behavior of Rhesus monkeys, sex factors, 20: 92

PUERTO RICO POWER REACTOR
containment structure for, design of, 20: 1512
pipe inspection results for preheater-dryer system of, (E), 20: 1471 (ORNL-TM-1282)

PULSE GENERATORS (ELECTRONICS)
design of square-wave, engineering drawings for, 20: 635
design of 25-V, engineering drawings for, 20: 638
development using plasma pinch effect, 20: 1281(T) (AD-620824)
time delay channels for, engineering drawings of, 20: 639

PULSE TRANSFORMERS
design for ignitron ignitor uses, engineering drawings for, 20: 636

PUPAE
radiosensitivity of insect, 20: 83

PYRIDINE-1-OXIDE
complexes with uranyl chlorides, proton magnetic resonance spectra of, 20: 301
proton magnetic resonance spectra of, proton chemical shifts of, 20: 301

PYRIDINES
methyl-, complexes with metals in 2,4-pentanedione and TTA, synergism in, 20: 261

PYROMETERS
use of infrared, in casting uranium ingots, 20: 784(R) (NLCO-965, pp 3.1-5)

Q

QUANTUM ELECTRODYNAMICS
polarization phenomena in, 20: 996 (NP-15204)

QUANTUM MECHANICS
bound states of Schroedinger equation, unstable, (T), 20: 1113
development of joint coordinate-momentum representation of, 20: 1080(T)
groups in, representations of continuous, 20: 740
master equation without random phases in initial state, (T), 20: 1112
operators in Hilbert space, 20: 737
Schroedinger equation in, group theoretical properties and invariant form of, (T), 20: 1110 (JINR-P-2306)
Schroedinger operators in three-dimensional Euclidian space, (T), 20: 1111
theory for elementary particles, 20: 1045(T)
theory for elementary particles, causality and determinism in, 20: 1048(T)
theory of elementary particles, 20: 1035(T)

8-QUINOLINOL, 5,7-DIIODO-
analytical use for determination of vanadium, 20: 257

R

RABBITS
cerium fluoride metabolism in lungs of, after intratracheal administration, tracer study, 20: 38
effects of solvents and stable rare earths on skin in, toxic, 20: 25(R) (TID-22294)
mucous membranes in, toxic effects of rare earth metals in contact with, 20: 25(R) (TID-22294)
radiation effects in, biological, 20: 43
radiation effects on lipid content of blood of, 20: 77
toxicity of nitrogen mustards in, 20: 43

RADAR
antennas of shipboard, method for predicting blast effects on, 20: 617 (AD-611540)

RADIATION
detection and measurement in flowing fluids, apparatus for, 20: 690(P)
detection and measurement in gases, semiconductor detector for, 20: 691(P)
dose estimation from contaminated food and milk in EURATOM countries, 20: 144 (EUR-2460.d,f,i,n)
dose to gonads from therapy of non-tumorous diseases, 20: 206
dosimetry using thermoluminescence, review on, 20: 656
dosimetry, definition of units for, 20: 611
effects in aqueous polymer solutions, effects of sulfur colloids, 20: 137
effects in man, genetic, 20: 202
effects of space flight encountered, bibliography on biological, 20: 56 (NASA-SP-7011(15))
effects on adrenal gland function in rats, protective effects of AET against, 20: 141
effects on biological systems sensitized with Hypericin, 20: 119
effects on chlorofluoroolefin induced reactions with dioxane, ethyl ether, and tetrahydrofuran, spectra of, 20: 395
effects on circuits and electronic components, 20: 695
effects on clad ceramic fuels, 20: 907
effects on crosslinking of polyethylene, polypropylene, and ethylene-propylene copolymer, 20: 402
effects on dilute aqueous solutions, mechanism and rate of, 20: 390
effects on DNA synthesis in mammalian cells, 20: 121
effects on enzymes, physiological, 20: 57(R) (NYO-901-37, pp 7-13)
effects on graft polymerization of acrylonitrile, butadiene, and styrene with cotton and rayon, 20: 363
effects on graft polymerization of acrylonitrile on polystyrene, polyvinyl-chloride, perchlorovinyl, and polyvinylalcohol, 20: 401
effects on immune reactions to tissue transplants, 20: 104
effects on immunity in animals, effects of lymph cell number on, 20: 55(R) (EUR-2469.f)
effects on learning ability of monkeys, 20: 92
effects on man, leukemogenic, dose factors, 20: 161
effects on man, perspective review on, 20: 106
effects on nucleic acids and nucleotides, ESR resonance spectroscopy of free radical formation in, 20: 421
effects on polyethylene, mechanism of radical decay in, 20: 385
effects on polymerization of solid diphenylvinyl phosphine oxide, 20: 399
effects on propylhydroperoxide reduction in rats by organic filtrates and serum, 20: 54
effects on reactor materials, 20: 1470(R) (NP-15407)
effects on thymic lymphocytes, effects of adrenal gland and splenic shielding on, 20: 142
hazards from diagnostic dental radiography, 20: 198
transport in one-dimensional rods, invariant-imbedding theory for, 20: 1315

transport in shielding materials, formulation of, (T), 20: 1303 (AD-614250)
use in agriculture, biology, and medicine, Russian conference on, 20: 11(T) (AEC-tr-6293)
use in diagnosis, energy levels for, 20: 182
uses in industry, survey of, 20: 702 (NYO-3337-16)
RADIATION CHEMISTRY
reactions of recoil carbon and tritium with organic compounds, 20: 359
yields of pure substances and mixtures in radiolysis, optical approximation of, 20: 365
RADIATION DETECTION INSTRUMENTS
circuit design for portable, 20: 683(P)
description of transistorized reactor pulse channel with boron trifluoride counter, 20: 1360
design for flowing fluid monitoring, 20: 690(P)
design for gamma-neutron surveying near reactors, 20: 1362
design for monitoring gases and vapors, 20: 682(P)
performance of, techniques for improving, 20: 655 (PHS-999-RH-15)
RADIATION DETECTION INSTRUMENTS (AUDIO PULSE TYPE)
design for monitoring alpha and beta particles, 20: 679(P)
RADIATION DETECTION INSTRUMENTS (ION CURRENT TYPE)
design, 20: 678(P)
RADIATION DETECTION INSTRUMENTS (PULSE TYPE)
design for detection and discrimination of airborne radioactivity, using a semiconductor solid state detector, 20: 691(P)
design for measuring beta and gamma activity of fluid samples, 20: 685(P)
design of alpha monitor for personnel, 20: 686(P)
performance for reactor noise analysis, 20: 1418
RADIATION DETECTORS
design of simulated, with associated optical system, 20: 689(P)
performance in HBWR, 20: 1466(R) (HPR-63)
performance of proton-recoil, for fast neutrons, (T), 20: 654 (NP-15466)
RADIATION EXPOSURE CHAMBERS
design of, for exposure of single cells, tissues, or animals, 20: 58(R) (NYO-901-37, pp 14-30)
RADIATION INJURIES
diagnosis in man by blood picture, 20: 116
diagnosis of, use of hematologic studies in man, 20: 64 (SZS-5(1965))
lens opacity, method for recording mouse, 20: 75
of intestinal tract induced by radiotherapy, 20: 192
of intestine induced by radiotherapy, 20: 178
of kidneys, pathology of, 20: 190
pathology of, 20: 121
pathology of intestinal, induced by radiotherapy of cervical carcinomas, 20: 186
pathology of intestinal, induced by radiotherapy of gynecologic cancers, 20: 210
pathology of rat brain, 20: 68
pathology of rectal, induced by radiotherapy, 20: 193
pathology of spinal cord, induced by radiotherapy of lung carcinoma, 20: 100
pathology of, in carcinomatous laryngeal mucosa, 20: 166(T) (N64-20943, pp 1--8)
pathology of, in mouse heart, liver, and kidneys, 20: 102
pathology of, in salamander cornea, 20: 82
protection against, effects of sodium cysteinethiosulfonate in mice, 20: 130
protection against, effects of triprolidine for ultraviolet, 20: 132
protection against, effects of bone marrow grafts, 20: 134
protection against, effects of desoxyribonucleic acid extracts in rats, 20: 136
protection against, effects of sulfur colloids in enzyme solutions, 20: 137
protection against ultraviolet, effects of visible light in ultraviolet-exposed mussels, 20: 139
protection against ultraviolet, effects of calcium chloride in mussels, 20: 139
protection against ultraviolet, effects of Dibazol in mussels, 20: 139
protection against, effects of aminoethylisothiuronium in rats, 20: 143
therapy using bone marrow, 20: 135
RADIATION MONITORING
data processing in Aerial Radiological Measuring Survey (ARMS II), system for electronic, 20: 520 (CEX-59.4(Pt.3))
equipment design for continuous, in gases and vapors, 20: 682(P)
equipment for gamma and neutron, for reactors, 20: 1362
instruments for, of reactors, 20: 1359
methods for atmospheric disposal control by, 20: 518
of personnel, system for hands, clothing, and shoes, 20: 607
of welding sites for excess radioactivity during radiography, 20: 606
programs at Argonne, New York, and New Zealand, 20: 521(R) (HASL-164)
whole-body counter for human, design of, 20: 659
RADIATION PROTECTION
measures for personnel at Rocky Flats plant, 20: 154 (RFP-621)
measures for radiologists during welding radiography, 20: 606
method for whole-body, during dental x-radiography, 20: 198
methods for tests during pregnancy, 20: 195
methods of, at JEN-1 Reactor, 20: 1538
of bone marrow, during diagnostic chest radiography, 20: 180
of radiologist during diagnostic radiography, 20: 188
regulations in Bulgaria, for laboratories, 20: 602(T) (JPRS-31747)
standards for, 20: 155(T) (JPRS-31646)
toxicity of radioisotopes, table of relative values for, 20: 145 (IA-939)
RADIATION SICKNESS
diagnosis of, in sheep and swine, 20: 128
therapy using bone marrow grafts, 20: 8(R) (STI/DOC/10/42, pp 23-43)
RADIATION SOURCES
list of available, from Radiochemical Center, Amersham, Buckinghamshire, England, 20: 698
preparation of mock iodine-131, for gamma spectrometry, 20: 416 (NP-15525)
RADIATION TARGETS
fabrication of neutron emissive, for use with high energy ion beams, 20: 1143(P)
fabrication of, summary of, 20: 696(R) (ORNL-3829)
preparation of isotopic, purification methods for, 20: 696(R) (ORNL-3829)
preparation of tritium, 20: 696(R) (ORNL-3829)
RADIO WAVES
propagation in ionosphere, data tabulation for July--Dec. 1964, 20: 1108
RADIOACTIVE CONTAMINATION
fossil fuel, levels in, 20: 152(R) (NYO-3086-1 Pt.VIII)
measurement on pig skin treated with solutions of radioisotopes, 20: 40
RADIOACTIVE MATERIALS
analysis of, electron-microprobe, 20: 224 (CNLM-6352)
depository for containers of, 20: 615(P)
handling and shipping of, container for, 20: 616(P)
list of available, from Radiochemical Center, Amersham, Buckinghamshire, England, 20: 698
porosity of, equipment for measuring, 20: 622 (LA-DC-7149)
production using underground explosions, 20: 730(P)
RADIOACTIVITY
containment of, methods for, 20: 518
diffusion from failed fuel elements, 20: 1466(R) (HPR-63)
layer in atmosphere over Barrow, Alaska, from Chinese nuclear test, 20: 531
release from loss-of-coolant accidents in power reactors, calculations, 20: 583 (CONF-650407, pp 970-83)
separation of beta, from Clinch River water using treatment plant, 20: 592 (K-C-785)
RADIOAPPLICATORS
design of shaped plastic material with imbedded cobalt-60 as, 20: 177
use of cobalt-60, for eye tumors, 20: 168
RADIOBIOLOGY
book: *Radiologic Studies of the Gravid Uterus*, 20: 214
design of data recording systems for, 20: 58(R) (NYO-901-37, pp 14-30)
elimination of radionuclides, review on, 20: 41
relative biological effectiveness of charged particle, relation of velocity to, (T), 20: 98
RADIOCHEMISTRY
method for analyzing lead-210 and strontium-90, 20: 417(R) (NYO-3086-1 Pt.IX)
research programs at Netherlands Reactor Center, 20: 1352(T,R) (JPRS-31526)
RADIODIAGNOSIS
effects in man, effects of dose on leukemogenic, 20: 161
hazards to man, 20: 202
method for liver diseases, using gold-198 colloids, iodine-131, or molybdenum-99 as tracer in, 20: 174
of brain tumors, use of mercury-203-chlormerodrin as tracer for, 20: 179
of goiter in children using iodine-131, 20: 185
preparation of labeled compounds for use in, 20: 200
use of radioisotopes for, bibliography, 20: 164 (TID-3077(Suppl.1))
use of radioisotopes for, review, 20: 207
use of technetium-99 in hepatic scintillography, 20: 197
RADIOGRAPHY
book: *Radiologic Studies of the Gravid Uterus*, 20: 214
diagnostic, during pregnancy, 20: 187
diagnostic, optimal energy for, 20: 182
hazards during welding, 20: 606
neutron, methods for enhancing film blackening in, 20: 667
of tumors, for treatment evaluation, 20: 184
radiation dose to bone marrow from chest, 20: 180
radiation hazards of dental, for dentists, 20: 59(R) (NYO-901-37, pp 31-2)
radiation hazards of diagnostic, to radiologist and technicians, 20: 188
radiation hazards of diagnostic, during pregnancy, 20: 195
radiation hazards from diagnostic dental, 20: 198
use for CP-5 reactor fuel quality evaluation, 20: 1533 (CONF-

650532-2)
RADIOISOTOPES
distribution in air and ground-deposited debris from nuclear cratering in basalt, 20: 613
elimination by biological processes, review on, 20: 41
handling and uses, engineering drawings of mobile laboratory for teaching, 20: 428
list of available, from Radiochemical Center, Amersham, Buckinghamshire, England, 20: 698
of chromosomes of leukocytes in tissue culture, effects of cell-cycle on, 19: 88
performance as heat source for rocket thrustor, 20: 724
preparation of, for medical uses, 20: 200
toxicity of, table of relative values, 20: 145 (IA-939)
use in agriculture, biology, and medicine, Russian conference on, 20: 11(T) (AEC-tr-6293)
use in medical research in Czechoslovakia, 1964, 20: 12
use in medicine, bibliography, 20: 164 (TID-3077(Suppl.1))
use in Poland, industrial, 20: 705
uses for measurement of spacecraft heat-shield sublimation and ablation, 20: 720
uses in industry, survey of, 20: 702 (NYO-3337-16)
uses in studying reaction mechanisms of organic compounds, 20: 348
uses in water engineering investigations, 20: 548
uses in wood technological problems, 20: 710
uses in wood technology, 20: 711
uses, in industries, 20: 706
RADIOLOGY
book: *Rediologic Studies of the Gravid Uterus*, 20: 214
radiation hazards to radiologist and technician, during diagnostic radiography, 20: 188
RADIOMETERS
performance for thermal flux rate measurement, comparison with other sensors, 20: 624 (SC-DC-65-1507)
RADIOMIMETIC SUBSTANCES
effects on Ehrlich ascites cells in mice compared with x radiation, mitomen, 20: 118
RADIOPROTECTIVE COMPOUNDS
contomin, effects in mice of, 20: 105
effectiveness of AET as, 20: 143
effectiveness of triprolidine against ultraviolet injuries of skin, 20: 132
effects of cysteinethiosulfonate against radiation injuries in rat sarcomas, 19: 131
effects of Dibazol for ultraviolet-induced injuries in mussels, 20: 139
effects of sodium cysteinethiosulfonate (CTS) in mice, 20: 130
RADIOSENSITIVITY
mechanisms of, in pocket mice, 20: 114
of face, 20: 183
of human tumors, in hamster cheek pouch culture, 20: 60(R) (NYO-901-37, pp 33-68)
protective effects of humidity and inositol against, of *Serratia marcescens*, 20: 99
RADIOSENSITIZERS
effects on irradiated biological systems of Hypericin, 20: 119
RADIOSTERILIZATION
of fish, effects on refrigerated storage life, 20: 701 (COO-1283-27)
of foods, status, 1965, 20: 719
of fruits, effects on storage life of prunes and strawberries, 20: 701 (COO-1283-27)
of insect populations of navel orangeworm, *Paramyelois transitella*, 20: 83
of pharmaceuticals containing terpenes, effects on stability, 20: 713
of potatoes, effects on storage life, 20: 701 (COO-1283-27)
of surgical sutures, effects on quality, 20: 703
RADIOTHERAPY
cosmetic, of face, contraindications, 20: 183
dose calculations for, use of computers for, 20: 167 (N64-20943, pp 35-46)
dose calculations in, 20: 204
effects of vitamin therapy on uterus, 20: 191
effects on kidney function, 20: 190
electron isodose in inhomogenous media for, photographic measurements of, 20: 162 (CONF-640918-2)
equipment for, design of linear accelerator, 20: 157
injurious effects of uterine, on intestine, 20: 210
isodose distributions in cobalt-60 tele-, computer equipment for plotting and reading, 20: 208
method for thyroid malignancies, 20: 196
of cancer, effects on leukemia incidence, 20: 60(R) (NYO-901-37, pp 33-68)
of cancers, medical care of patients during, 20: 184
of carcinoma of the uterus, late pathological effects on intestine, 20: 186
of carcinomas of the uterus, effects on rectum, 20: 193
of carcinomas of uterus, effects on lymph node metastases, 20: 212
of carcinomas, sarcomas induced by, 20: 211
of hyperthyroidism, use of iodine-131 for, 20: 181
of tumors of mammary gland, pathological effects on heart, 20: 213
of tumors of skin, use of gamma or x ray sources for, 20: 171
of tumors, synergistic effects of chemotherapy, 20: 194
of uterine tumors, radiation injuries of rectum induced by, 20: 178
preparation of labeled compounds for use in, 20: 200
radiation injuries of intestinal tract induced by, 20: 192
radiation sources for skin-tumor, use of cobalt-60 imbedded in plastic material as, 20: 177
supervoltage, of cancer, 20: 205
use during pregnancy, hazards from, 20: 199
use in treatment of Hodgkin's disease during pregnancy, 20: 209
use of radioisotopes for, bibliography, 20: 164 (TID-3077(Suppl.1))
RADIOTOXICITY
of radionuclides, table of relative values, 20: 145 (IA-939)
RADIUM
effects on chromosome patterns in man, chronic exposure, 20: 60(R) (NYO-901-37, pp 33-68)
transport vessels for, 20: 160
use for therapy of cervical carcinomas, 20: 186
RADIUM ISOTOPES Ra-224
effects on serum lactic dehydrogenase levels in beagles, by internal deposition, 20: 112
metabolism in beagles from thorium-228 decay, 20: 42
RADIUM ISOTOPES Ra-226
content in bones of radium dial painters, 20: 22(R) (NYO-3086-1 Pt.II)
content in food, teeth and water in Brazil, 20: 150(R) (NYO-3086-1 Pt.VI)
content in human body and bones, 20: 603
content in natural and processed materials in Australia, 20: 156
effects on productivity of algae, 20: 26(R) (TID-22322)
effects on serum dehydrogenase levels in beagles, by internal deposition, 20: 112
measurement in radium dial painters, whole-body, 20: 147(R) (NYO-3086-1 Pt.I)
RADIUM ISOTOPES Ra-228
content in bones of radium dial painters, 20: 22(R) (NYO-3086-1 Pt.II)
content in dog bones following injection, 20: 23(R) (NYO-3086-1 Pt.III)
content in food, teeth and water in Brazil, 20: 150(R) (NYO-3086-1 Pt.VI)
content in human diet, 20: 148(R) (NYO-3086-1 Pt.IV)
effects on serum lactic dehydrogenase levels in beagles, by internal deposition, 20: 112
RADIUM POISONING
effects on bones, pathological, 20: 60(R) (NYO-901-37, pp 33-68)
RADON ISOTOPES Rn-220
detection of, from sealed radium-226 and thorium-228 sources, 20: 601 (RCC-R-176(Add.))
RADON ISOTOPES Rn-222
detection of, from sealed radium-226 and thorium-228 sources, 20: 601 (RCC-R-176(Add.))
release from soils into atmosphere, 20: 528
use in tracer studies of vertical diffusivity of atmosphere, 20: 528
RAIN WATER
cesium-137, potassium-40, radium-226, and strontium-90 contents in, in Australia, 20: 156
radioactive contamination in Japan, effects of weapons testing on, 1959 to 1962, 20: 534
sample collection of, from hurricanes, 20: 519
tritium content of, from hurricanes, 20: 519
RARE EARTH COMPOUNDS
book: *The Chemistry of the Rare Earth Elements*, 20: 219
RARE EARTH NITRATES
infrared spectra of anhydrous, in 100–4000-cm^{-1} region, (E), 20: 308
RARE EARTH OXIDES
properties of nonstoichiometric, magnetic and paramagnetic, 20: 880
RARE EARTH SULFIDES
rare earth sulfides–SrS, crystal structure of solid solutions in, 20: 332
BaS–rare earth sulfides, crystal structure of solid solutions in, 20: 332
CaS–rare earth sulfides, crystal structure of solid solutions in, 20: 332
MgS–rare earth sulfides, crystal structure of solid solutions in, 20: 332
MnS–rare earth sulfides, crystal structure of solid solutions in, 20: 332
RARE EARTH TUNGSTATES
hydration, 20: 307
RARE EARTHS
book: *The Chemistry of the Rare Earth Elements*, 20: 219
effects on electric conductivity of cerium, 20: 864
separation from thorium, chromatographic, 20: 449

separation of light, evaluation of eluting agents in ion exchange, 20: 429 (BNWL-69)
RARE GASES
diffusion in solids, research program on, 20: 1324(R) (EURAEC-1428)
quantum- and correlation-corrected Thomas-Fermi-Dirac equation for atoms of, 20: 972
RATE METERS
circuit design for portable, 20: 683(P)
development of solid state, for alpha, beta, gamma, and neutron activities, 20: 646 (AD-614432)
RATS
breeding program for experimental, 20: 60(R) (NYO-901-37, pp 33-68)
care of experimental, design of facilities for, 20: 3 (LF-23)
cerium-144 metabolism in bones of, autoradiographic study, 20: 34
hypertension-induction in, effects of genetic background on, 20: 1558 (BNL-9404)
mitotic index in bone marrow of, effects of AET on, 20: 143
radiation dose to Brazilian, from background activity, 20: 151(R) (NYO-3086-1 Pt.VII)
radiation effects on nervous system development in embryos, 20: 60(R) (NYO-901-37, pp 33-68)
radiation effects in, biological, 20: 43
radiation effects on collagen synthesis by subcutaneous granulomas in, 20: 52
radiation effects on propylhydroperoxide reduction by organic filtrates and serum from, 20: 54
radiation effects on excretion of bile acids by livir of, 20: 78
radiation effects on immune reactions to parental spleen cell grafts in, 20: 86
radiation effects on nucleic acid metabolism in lens of, tracer study, 20: 89
radiation effects on sulfhydryl content in skin of, uv, 20: 93
radiation effects on mitotic index in liver cells in, 20: 95
radiation effects on thiol content in liver and spleen in, whole-body, 19: 108
radiation effects on DNA synthesis in liver of, 20: 121
radiation effects on adrenal gland function in, protective effects of AET against, 20: 141
radiation effects on response to leukopoiesis-stimulating drugs in, 20: 194
radiation injuries of brain of, pathology, 20: 68
radiosensitivity of, effects of AET on, 20: 143
strontium-90 metabolism in lactating, 20: 35
toxicity of nitrogen mustards in, 20: 43
tumor-induction in, effects of cadmium injection and vascular ligation on interstitial cell, 20: 10 (TID-21261)
REACTOR COMPONENTS
development review, 20: 1513
REACTOR CONTROL RODS
breaks in, design of electric device for monitoring, 20: 1394(P)
design of operating device for, for liquid metal-cooled reactor, 20: 1369(P)
drive mechanism for, design of, 20: 1388(P)
shock-absorbing device for, 20: 1393(P)
REACTOR CONTROL SYSTEMS
design for circulating neutron absorbent material through core, 20: 1373(P)
design for emergency shut-down, 20: 1372(P)
design of automatic, 20: 1395(P)
design of coolant-regulated, 20: 1371(P)
design of transistorized pulse channel with high resolution, 20: 1360
design of transistorized d-c channels for, 20: 1361
design with primary and secondary shutdown systems, 20: 1407(P)
REACTOR COOLANTS
decontamination of gaseous, plant for, 20: 1397(P)
processing Dragon, 20: 1470(R) (NP-15407)
REACTOR COOLING SYSTEMS
coolant flow in, device for measuring rate of, 20: 1398(P)
decontamination of gas-cooled-plant for, 20: 1397(P)
design, 20: 1408(P)
design, 20: 1425(P)
design for liquid moderated reactor, 20: 1403(P)
design of heat exchange system for, 20: 1400(P)
design of, for swimming-pool reactors, 20: 1370(P)
fission product transport and deposition in gaseous, model for, (T), 20: 1349 (ORNL-TM-1274)
REACTOR ENGINEERING
design of dual-coolant reactor, 20: 1424(P)
developments in, review of, 20: 1513
evaluation of concrete and steel structures in, 20: 1312
provisions to ensure operational safety of instrumentation, 20: 1363
research programs at Dragon on, 20: 1470(R) (NP-15407)
REACTOR EXPERIMENTAL FACILITIES
design of materials testing apparatus, 20: 1385(P)
design of pneumatic transport tube container, 20: 1382(P)
design of specimen support for, 20: 1378(P)
REACTOR FUEL ELEMENTS
analysis of irradiated, for fission products by gamma spectrometry, 20: 236(T) (AEC-tr-6621)
burnup of irradiated, methods for nondestructive measurement of, 20: 231(R) (NP-15344)
burnup of MTR-type, semiconductor gamma spectrometer for analysis of, 20: 1440
can design for, 20: 1445(P)
can design for, 20: 1449(P)
coating with aluminum, method for, 20: 802(P)
corrosion of Dragon, studies of, 20: 1470(R) (NP-15407)
design of assembly, with tubular graphite casings, 20: 1451(P)
design of concentric tubular canned, 20: 1443(P)
design of coupled, 20: 1446(P)
design of hollow sheathed, to maintain contact between sheath and fuel during operation, 20: 1450(P)
design of instrumented, for PRO reactor, 20: 1473 (RT/ING(64)12bis)
design of pin assembly with support plate, 20: 1442(P)
design of self-purging, for gas-cooled reactors, 20: 1441(P)
design with hold-down arrangement for water-moderated reactors, 20: 1431(P)
development for power reactors, 20: 1496
development of instrumented, for PRO reactor, 20: 1472 (RT/ING(64)-12)
development review, 20: 1513
examination of irradiated EGCR prototype, 20: 891 (GEAP-3893)
failure detection device for heterogeneous reactors, 20: 1396(P)
failure detection system for, 20: 1466(R) (HPR-63)
failure in gas-cooled reactors, device for detecting, 20: 1379(P)
failure in reactors, detection system for, 20: 1406(P)
failure of, device for detecting, 20: 1375(P)
failure of, in boiling-water reactors, gamma-spectrometric evaluation of, 20: 853
fission density distribution in, autoradiography of, 20: 1438
fission product deposition from irradiated uranium carbide, in out-of-pile loops, 20: 572 (CONF-650407, pp 655-97)
fission product release from planned and unplanned defects in uranium–dioxide, into coolant systems, 20: 555 (CONF-650407, pp 1-37)
fission product release from melted stainless-steel-clad uranium dioxide, atmospheric effects on, 20: 559 (CONF-650407, pp 276-91)
fission product release from defected uranium-dioxide, of different lengths, 20: 890 (EXP-NRX-21406)
handling apparatus for gas-cooled reactors, 20: 1399(P)
handling device for, 20: 1391(P)
iodine content in irradiated, burnup dependence of, 20: 1539
iodine release from irradiated uranium dioxide, techniques for characterization of, 20: 281 (CONF-650407, pp 1096-1109)
iodine release from irradiated, experiments on, 20: 578 (CONF-650407, pp 830-52)
machining of magnox, waste processing of swarf from, 20: 1554
neutron collision probabilities in cluster-type, method of calculating, (T), 20: 1138
preparation by incorporation of fissile materials in vitreous systems, 20: 1556
preparation of, metallographic methods for, 20: 797
processing of depleted uranium, method and device for electrolytic, 20: 454(P)
processing of irradiated, for plutonium and uranium recovery, 20: 432(R) (EURAEC-1402)
processing of irradiated, properties of quaternary ammonium nitrates for, 20: 446
radiation effects on, test program in HBWR, 20: 1466(R) (HPR-63)
radiation effects on clad, summary of HBWR tests, 20: 1466(R) (HPR-63)
separation of uranium from spent, by fused-salt fluoride-volatility process, 20: 442
temperature measurements in reactor channels, device for, 20: 1368(P)
testing in TREAT, 20: 1542
weighing apparatus for column of pellets, 20: 1444(P)
REACTOR FUEL ELEMENTS (CERAMIC)
design and fabrication of clad, for Big Rock Point reactor, 20: 1465(R) (GEAP-4894)
development of uranium oxide, for Nero project, 20: 1352(T,R) (JPRS-31526)
fabrication of compacts of, method for, 20: 804(P)
fabrication of grid-type, by pneumatic impaction, 20: 809(P)
fabrication of uranium mononitride–uranium dioxide, 20: 807(P)
fabrication of, method for, 20: 808(P)
performance of plutonia–uranía, in water moderated reactors, (T), 20: 1436 (GEAP-4907)

performance of Zircaloy-2-clad urania, with central melting, irradiation, 20: 893 (GEAP-5100A)
radiation effects on cladding-urania interfaces of, 20: 1465(R) (GEAP-4894)
radiation effects on metal-clad, 20: 907
radioinduced failure of Zircaloy-clad, 20: 1466(R) (HPR-63)
testing in SPERT-I, destructive, 20: 1416
REACTOR FUEL ELEMENTS (DISPERSION)
preparation of coated spherical particles of plutonium dioxide and plutonium dioxide–uranium dioxide for, 20: 747 (EURAEC-1391)
uranium distribution in urania–zirconia–paraffin, method for measurement of, 20: 227 (KAPL-M-6448)
REACTOR FUEL ELEMENTS (THERMOELECTRIC)
design and fabrication for naval applications, 20: 1437(R) (GEST-2047)
REACTOR FUEL PINS
radiation effects on stainless steel-clad plutonium dioxide–uranium dioxide, transient, 20: 892 (GEAP-4804)
REACTOR FUEL PLATES
dissolution of aluminum and aluminum–uranium MTR, mercury-catalyzed nitric acid, 20: 438 (RT/CHI(65)23)
fabrication for Netherlands research reactor, 20: 1535
fabrication of, quality control in, 20: 795
REACTOR FUEL RODS
canning machine for, 20: 805(P)
fabrication of, nondestructive tests in, 20: 794
fission product release from Zircaloy-2-clad uranium dioxide fuel rods operated at high power rating, 20: 579 (CONF-650407, pp 885-907)
neutron absorption cross sections of, assembly for measuring, 20: 1384(P)
neutron resonance escape probability for, computer program for calculating, 20: 1133 (IDO-17075)
neutron resonance integrals for thorium dioxide and uranium carbide and dioxide, 20: 1148 (CRRP-1222)
performance of Zircaloy-2-clad urania, with central melting, irradiation, 20: 893 (GEAP-5100A)
radiation effects on profiles of clad ceramic, 20: 1465(R) (GEAP-4894)
support systems for, spacers for, 20: 1409(P)
temperature of sheath of, computer program for calculating, 20: 480 (AECL-2269)
testing of, methods of nondestructive, 20: 794
REACTOR FUEL TUBES
design of sheathed cylindrical, 20: 1448(P)
development and testing, 20: 1466(R) (HPR-63)
extrusion of Zircaloy-2-clad thorium–uranium, 20: 782 (DP-943)
heat treatment process for uranium, 20: 785(R) (NLCO-965, pp 5.1-10)
testing in hot cells, engineering drawings of profilometer for, 20: 494
REACTOR FUELS
analysis for plutonium-239 by neutron transmission measurements, 20: 233 (SGAE-PH-28/1965)
analysis for uranium-235 by neutron activation methods, 20: 241
analysis of unirradiated and irradiated, for plutonium and uranium, 20: 234(R) (STI/DOC/10/42, pp 57-8)
burnup of, computer program for analyzing, 20: 1421 (AD-611775)
cycle analysis for Dragon, 20: 1470(R) (NP-15407)
development, 20: 1534(R) (LA-3370)
development and economics of, in Japan, 20: 1439
development for European power reactors, 20: 1463 (EUR-2445.f)
economics of plutonium recycle in water-moderated reactors, (T), 20: 1436 (GEAP-4907)
economics of, in Europe, 20: 1469 (KFK-359)
fabrication of compacts of, method for, 20: 804(P)
fabrication of spherical particles of, by powder agglomeration method, 20: 793
fabrication of titanium nitride–uranium nitride, method for, 20: 803(P)
fission gas release from carbon-coated fuel particles at high temperatures, 20: 899
fission product distribution in canned molten plutonium, gamma scanner for, 20: 1534(R) (LA-3370)
fission product release from coated-particle, in gas-cooled reactors under accident conditions, 20: 556 (CONF-650407, pp 56-72)
processing of irradiated ceramic, methods for, 20: 432(R) (EURAEC-1402)
processing of irradiated, pre-decontamination for, 20: 452(P)
processing of irradiated uranium–plutonium, 20: 455(P)
reprocessing at Savannah River Plant, nuclear safety control in, 20: 431 (CONF-651103-7)
sintering of uranium nitride, 20: 806(P)
storage of coated-particle, criticality studies for, 20: 591 (GAMD-6623)
testing of, fast reactor for, 20: 1546(P)
REACTOR MATERIALS
analysis for boron, mass spectrometric, 20: 235 (Y-KG-28)
fabrication of magnesium-based, 20: 801(P)
mechanical properties of, research program on, 20: 819(R) (GA-6413)
properties and use for space vehicles, conference on, 20: 877
REACTOR MATRICES
design, 20: 1434(P)
design for molten salt reactor, 20: 1423
REACTOR MODERATORS
construction of solid, 20: 1390(P)
design of graphite, 20: 1383(P)
dimensional stability of, design of compensation means for, 20: 1377(P)
iodine-131 content in HBWR, 20: 1466(R) (HPR-63)
seal design for block assembly of, 20: 1380(P)
support structure for vertically stacked, 20: 1404(P)
support structure for, belt restraint type, 20: 1405(P)
support structure for solid, vertically arranged, 20: 1389(P)
support structures for vertically-stacked solid, 20: 1376(P)
REACTOR REFLECTORS
support structure for, belt restraint type, 20: 1405(P)
REACTOR SAFETY
analysis for boiling reactors, performance of models for, 20: 1455 (AWRE-R-3/65)
analysis of blowdown accidents, program for evaluation of data for, 20: 570 (CONF-650407, pp 609-40)
analysis of power reactors, probabilistic methodology for, 20: 1461 (CONF-650407, pp 1035-56)
at Elk River Power Plant, 20: 1547 (CEND-512)
conference on fission product release and transport under accident conditions, 20: 554 (CONF-650407)
containment and siting of large power reactors, 20: 1460 (CONF-650407, pp 1015-34)
developments in, review of, 20: 1353
effluent flow around buildings, 20: 562 (CONF-650407, pp 455-9)
fission product behavior, French research program on, 20: 568 (CONF-650407, pp 578-86)
fission product dispersion in atmosphere from reactor accident, calculations, 20: 560 (CONF-650407, pp 362-80)
fission product release from coated-particle fuels under accident conditions, 20: 556 (CONF-650407, pp 56-72)
fission product release in accidents, Swedish research program on radiological consequences of, 20: 569 (CONF-650407, pp 603-8)
fission product release program, 20: 571 (CONF-650407, pp 641-7)
fission product release from EGCR core, studies, 20: 581 (CONF-650407, pp 921-37)
fission product release from accidents to atmosphere, techniques for limiting, 20: 585 (CONF-650407, pp 1000-14)
fission product transport after loss-of-coolant accident, in pressure suppression containment, 20: 575 (CONF-650407, pp 753-75)
for heavy water reactors, 20: 927
hazards calculation, computer program for, 20: 1348 (CONF-650407, pp 1057-70)
hazards evaluation of different accidents, method for analysis of, 20: 587 (CONF-650407, pp 1080-90)
iodine behavior in reactor accidents, experiments on, 20: 578 (CONF-650407, pp 830-52)
loss-of-coolant accident analysis, calculations of zirconium-steam reactions in, 20: 582 (CONF-650407, pp 938-69)
loss-of-coolant accident analysis for power reactors, calculation of radioactivity release in, 20: 583 (CONF-650407, pp 970-83)
maximum credible accident concept for power reactors, 20: 580 (CONF-650407, pp 908-20)
radioactivity release from Carolinas-Virginia Tube Reactor, atmospheric diffusion map overlays for, 20: 561 (CONF-650407, pp 439-54)
safeguards in power reactors, engineered, 20: 586 (CONF-650407, pp 1071-9)
REACTOR SAFETY EXPERIMENTS
description of Loss-of-Fluid Test (LOFT) program, 20: 567 (CONF-650407, pp 567-77)
destructive test SNAPTRAN 2/10A-3, fission product release and dispersion from, 20: 564 (CONF-650407, pp 512-36)
effluent from TNT test of Kiwi reactor, 20: 566 (CONF-650407, pp 557-65)
fission product releases from nuclear excursions into atmosphere, 20: 563 (CONF-650407, pp 497-511)
fission product removal from protective coatings in LOFT test, 20: 573 (CONF-650407, pp 720-9)
fuel element testing in SPERT-I, destructive urania, 20: 1416
fuel meltdown in TREAT, review of, 20: 1542
metal-water reactions in TREAT, review of, 20: 1542
radioactivity release from TNT test of Kiwi reactor, 20: 565 (CONF-650407, pp 537-56)
reactivity excursion test of SPERT II close-packed core, 20: 1412 (IDO-17109)
transient effects on plutonium dioxide–uranium dioxide fuel pins in TREAT, 20: 892 (GEAP-4804)
REACTOR SHIELDING

design of two-material, weight optimization in, (T), 20: 1319
neutron fluxes and spectra in concrete and water, fast, (E/T), 20: 1318
neutron fluxes in annular ducts through laminated iron-heavy water, (E/T), 20: 1317
neutron spectra in laminated iron–water, fast, (E/T), 20: 1304 (AE-196)
properties and testing of concrete and steel, 20: 1312
REACTOR SLURRIES
development of thickened, 20: 1447(P)
REACTOR THERMAL COLUMNS
design, 20: 1386(P)
REACTOR TUBES
corrosion in PRTR, surveillance program on fretting, 20: 1367
stress distribution at normally intersecting cylindrical, (T), 20: 466
REACTORS
accidents in, computer program for shock wave calculation from, 20: 1350 (TIM-950)
control of, parallel-plate multisection ionization chambers for, 20: 1357 (ORNL-P-1432)
cooling system for liquid moderated, design of, 20: 1403(P)
core design, 20: 1426(P)
design classification of, proposed standard for, 20: 1354
design of, model analysis of aseismic, 20: 1355
fuel depletion in, computer program for analyzing, 20: 1421 (AD-611775)
fuel rod spacer systems for, 20: 1409(P)
kinetics of, integrodifferential equations in, 20: 1420
loading apparatus for, 20: 1401(P)
loading device for, 20: 1391(P)
loading equipment for, 20: 1392(P)
loading machine for, 20: 1402(P)
neutron field spatial and spectral coupling in, (T), 20: 1411 (CONF-650413-13)
neutron flux density and radiation monitoring of, instrumentation for, 20: 1359
neutron noise of, detector output pulses for, (T), 20: 1418
neutron spectra in, threshold detector data evaluation on, 20: 1414
neutron transport theory for, invariant-imbedding techniques in, 20: 1415
power level of, equations for, (T), 20: 1417
pressure vessels for, stress concentrations in nozzle rings of, 20: 1365
shut-down device for, 20: 1372(P)
transfer functions of, reduced delayed neutron model for, 20: 1356
RECTIFIERS
ignitor pulse transformer for, engineering drawings of, 20: 636
REFRACTORY MATERIALS
fatigue behavior of alloys at high temperatures in ultrahigh vacuum, research program on, 20: 824(R) (NASA-CR-54458)
melting points of, method for measuring, 20: 798
vaporization at high temperatures, thermodynamics of, 20: 283 (COO-1140-129)
wear in blast furnaces, use of cobalt-60 gamma sources for measuring, 20: 715
REFRIGERATION
development for cryogenic magnets, 20: 1265 (NBS-3346)
performance of pulsed cryogenic systems for thermonuclear research, 20: 1263 (NBS-8817)
RELATIVITY THEORY
covariance principle and planetary orbit stability in general, 20: 1116
tests of Einstein and Peebles-Dicke, using momentum/velocity ratios of fast particles, (E), 20: 1117
REMOTE-CONTROL EQUIPMENT
description of balance for weighing in hot cell, 20: 476 (LA-DC-7150)
design for reactor loading, 20: 1392(P)
design of filter photometer for hot cells, engineering drawings for, 20: 275
design of porosimeter for radioactive samples, 20: 622 (LA-DC-7149)
design of two-piece manipulator boot, 20: 477 (ORNL-P-1385)
use of distributed-carrier multiplex, for control of CERN accelerators, 20: 933 (CERN-65-28)
RESEARCH REACTORS
design and development of Netherlands Research Center KRITO, 20: 1352(T,R) (JPRS-31526)
design and use at Studsvik research center, 20: 1540
design of high-flux, 20: 1545(P)
design of Russian, 20: 1351 (WASH-1060)
development of homogeneous suspension, 20: 1352(T,R) (JPRS-31526)
development of, summary of Third Geneva Conference papers on, 20: 1537
fission products in recombiner of L54 Milan, effects of burnup on delayed neutron precursor, 20: 1539
fuel plate fabrication for, in Netherlands, 20: 1535
fuel solution in Berlin Research Reactor, corrosion products in, 20: 1541
operation of Netherlands Reactor Center high- and low-flux, 20: 1352(T,R) (JPRS-31526)
reactivity measurements in HECTOR, 20: 1543
RESISTANCE THERMOMETERS
development of thin film for shock tube applications, 20: 618 (AWRE-O-58/65)
RESISTORS
radiation effects on resistance of thin-film, method for measuring, 20: 694
RESPIRATORY TRACTS
radiation doses from deposited particles, calculation using cascade impactor data, 20: 588 (CONF-650407, pp 1162-1203)
RETICULO-ENDOTHELIAL SYSTEM
physiology of cells of, 20: 61(R) (NYO-901-37, pp 69-73)
radiation effects on phagocytic activity of cells of, in tissue culture, 20: 85
role in passage of particles from peritoneal cavity into diaphragmatic lymphatics in mice, 20: 16
RHENIUM
determination in rocks, activation, 20: 226 (IS-T-39)
etching dislocations on oriented single-crystal faces of, 20: 866
ionization coefficients for, (E), 20: 757
radiation effects on dislocation channeling in deformed, neutron, 20: 745(R) (BNWL-120, pp 3.1-22)
rare earth ionization and oxidation on, in oxygen atmosphere, 20: 757
solubility in plutonium at 700 to 950°C, 20: 1534(R) (LA-3370)
vapor pressure, 20: 331
vaporization of, under vacuum and forced convection conditions, (T), 20: 831 (UCRL-14274)
RHENIUM COMPLEXES
with biguanide hydroxide and hydroxo acetate, chloride, and sulfate, properties and spectra of, 20: 320
RHENIUM ISOTOPES Re-185
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173
RHENIUM ISOTOPES Re-186
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)
RHENIUM ISOTOPES Re-187
energy levels, (E), 20: 1179
proton reactions (p,2n) with, conversion electron spectra from, (E), 20: 1173
RHENIUM ISOTOPES Re-188
decay scheme for isomeric, (E), 20: 1145 (BNL-8168)
isomeric transitions in, hindrance factor of K-forbidden, (E/T), 20: 1145 (BNL-8168)
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)
RHENIUM ISOTOPES Re-190
nucleon coupling in, parity and spins for, (T), 20: 1145 (BNL-8168)
RHODIUM
vapor pressure, 20: 331
RHODIUM ISOTOPES Rh-101
decay of isomers of, electron-capture and gamma, (E), 20: 1205
RHODIUM ISOTOPES Rh-103
proton reactions (p,2n) with, conversion-electron spectra from, (E), 20: 1173
RHODIUM ISOTOPES Rh-106
determination in irradiated fuel elements by gamma spectrometry, 20: 236(T) (AEC-tr-6621)
RIBONUCLEASE
radiation effects on disruption of specific cystines in, uv, 20: 51
radiation effects on structure of solid, 20: 53
radiation effects on, maximum permissible dose from proton, 20: 107
synthesis and storage of tritiated, 20: 2 (EUR-2419.1)
RIBONUCLEIC ACID
radiation effects on content in rat skin, uv, 20: 93
RIBONUCLEIC ACID, DESOXY-
metabolism in human leukemia cells, tracer study, 20: 20 (EUR-2451.e)
metabolism of tritium-labeled, in granulopoiesis, 20: 1 (BNL-9363)
protective effects of, against radiation injuries in rats, 20: 136
radiation effects on, effects of molecular weight on free radical yield in, 20: 420
radiation effects on, in bacteria, 20: 45(R) (EUR-2471.1)
radiation effects on metabolism in carrot tissues and tomato stems, x, 20: 120
radiation effects on synthesis of, in rat liver, 20: 121
radiation effects on content in rat skin, uv, 20: 93
radioinduced free radicals in, ESR spectroscopy of, 20: 421
radiosensitizer incorporation in, injurious effects of, 20: 119
stability of hydrogen bonds in, deuterium effects on, 20: 14(T)
RICKETS
calcium metabolism in human, calcium-47 study of, 20: 8(R) (STI/DOC/10/42, pp 23-43)
ROCKET REACTORS
critical mass of gaseous-core, 20: 1531
design of, with gaseous fuel for operation at very high temperatures, 20: 1532(P)

ROCKET REACTORS (KIWI)
fuel element fission density distribution in, autoradiography of, 20: 1438
transient test of, radioactivity release from TNT, 20: 565 (CONF-650407, pp 537-56)
transient test of, effluent from, 20: 566 (CONF-650407, pp 557-65)
ROCKETS
development of 15-mlb-thrust ion-beam engines, (E), 20: 498 (NASA-CR-54136)
propellant gage for, use of krypton-85 in, 20: 721
propulsion of, gamma radioisotope thrustor for, 20: 724
ROCKS
age estimation of, by potassium–argon and rubidium–strontium methods in Llano Uplift, Texas, 20: 532
analysis for rhenium, activation, 20: 226 (IS-T-39)
engineering properties of basalt, from Pre-Schooner sites in Backboard Mesa, Nevada Test Site, 20: 511 (PNE-505P)
stresses in hard, from nuclear explosions, 20: 495
stresses in, from surface nuclear explosions, 20: 496
RODS
radiation transport in one-dimensional, invariant-imbedding theory for, 20: 1315
ROOTS
radiation effects on growth of *Vicia faba*, of continuous low dose-rate x or gamma exposure, 20: 87
ROSE BENGAL
use of iodine-131-labeled, in liver scanning, 20: 174
RUBBER
radioinduced polymerization with methyl methacrylate, 20: 367
RUBIDIUM
content in chondrites and chondrules, age estimation from, 20: 529
RUBIDIUM AMERICYL FLUORIDES
preparation and lattice constants, 20: 305
RUBIDIUM CHLORIDES
ion self-diffusion mobilities in, determination from tracer transfer rate coefficients, 20: 425
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
RUBIDIUM CHROMATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
RUBIDIUM ISOTOPES Rb-86
exchange in rubidium chloride solutions, rate coefficients for, 20: 425
RUBIDIUM ISOTOPES Rb-87
content in chondrites and chondrules, age estimation from, 20: 529
content in igneous and metamorphic rocks, Llano Uplift, Texas, 20: 532
RUBIDIUM NEPTUNYL FLUORIDES
preparation and lattice constants, 20: 305
RUBIDIUM PLUTONYL FLUORIDES
preparation and lattice constants, 20: 305
RUSSIAN REACTORS
design characteristics, 20: 1351 (WASH-1060)
design of Kurchatov, comparison with Dresden Power Reactor, 20: 1484
design of Novovoronezh, comparison with Indian Point, 20: 1483
RUTHENIUM
separation from low-level waste water, 20: 1549 (ORNL-3811)
vapor pressure, 20: 331
RUTHENIUM ISOTOPES Ru-101
energy levels from rhodium-101m and -101g decay, (E), 20: 1205

S

SACLAY REACTORS (OSIRIS)
automation of, centralized data processing equipment for, 20: 1536
SAFETY
civil liability for nuclear, 20: 609
control of nuclear, in chemical processing facilities of Savannah River Plant, 20: 431 (CONF-651103-7)
hazards of coal-driven power plants, 20: 610
in shipment of explosives, 20: 594 (LA-DC-7469)
review of progress on nuclear, 20: 608
SAFETY HAZARDS
protection against plutonium, at Rocky Flats plant, 20: 154 (RFP-621)
SALAMANDERS
radiosensitivity of cornea in *Siredon mexicanum*, effects of age, 20: 82
SAMARIUM
determination of, in rare-earth mixtures, photometric, 20: 252
ionization and oxidation on rhenium and tungsten in oxygen atmosphere, 20: 757
oxidation of, heats of reaction for, (E), 20: 757
thermal hysteresis of magnetic transitions in polycrystalline, 20: 851
SAMARIUM ALLOYS
Sm–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
SAMARIUM ISOTOPES Sm-153
decay, (E), 20: 1178
distribution from nuclear excavation in basalt, 20: 613
SAMARIUM NIOBATES
preparation and structure of perovskite type, 20: 844
SAMARIUM OXIDES
$BaO–Sm_2O_3$, phase studies, 20: 302
$Sc_2O_3–ThO_2$, phase diagram, 20: 839
$Sm_2O_3–SrO$, phase studies, 20: 302
SAMARIUM OXYBROMIDES
preparation and structure of, 20: 869
SAMARIUM TANTALATES
preparation and structure of perovskite type, 20: 844
SAMPLING
equipment for high-altitude, 20: 620 (COO-401-118)
SAN FRANCISCO BAY AREA (CALIF.)
radium-228 monitoring in foods at, 20: 148(R) (NYO-3086-1 Pt.IV)
SANDS
erosion and displacement by surf, tracer studies, 20: 510 (EUR-2167.d)
SAP (SINTERED ALUMINUM PRODUCTS)
crystal structure and properties of, effects of heat treatments above melting point on, 20: 842
SARCOMAS
growth of x-irradiated viruses of Rous, on chick embryo chorioallantoic membrane, 20: 103
radiation effects on growth of transplanted, in mice, effects of sodium cysteinethiosulfonate on, 20: 131
radiodiagnosis in bones using calcium-47, 20: 8(R) (STI/DOC/10/42, pp 23-43)
radioinduced, by radiotherapy of carcinomas, 20: 211
SATELLITES
orbits of, relativity theory for perihelion precession of, 20: 1116
power plant for, torque production by SNAP-10A, (T), 20: 1528 (NAA-SR-11207)
SAVANNAH RIVER COMPONENTS TEST REACTOR
fabrication and irradiation testing of Zircaloy-clad thorium–uranium fuel tubes, 20: 782 (DP-943)
SAVANNAH RIVER PLANT
chemical processing facilities of, nuclear safety control in, 20: 431 (CONF-651103-7)
waste handling at, low- and medium-level liquid, 20: 1548 (DPSPU-65-30-30)
SAXTON POWER REACTOR
design and operation of, review on, 20: 1508
SCANDIUM ALLOYS
Pu–Sc, crystal structure and phases of, 20: 1534(R) (LA-3370)
SCANDIUM HYDRIDES
formation in hydrogen–scandium systems, 20: 322
SCANDIUM ISOTOPES Sc-42
nucleon-nucleon interactions in, core polarization effects in two-body, (T), 20: 1186
SCANDIUM ISOTOPES Sc-44
photoproduction of isomeric, yield ratios for, (E/T), 20: 1246
SCANDIUM ISOTOPES Sc-45
energy levels from calcium-45 beta decay, (E), 20: 1206
photon reactions at 300 Mev peak, isomer production in, (E/T), 20: 1246
SCANDIUM ISOTOPES Sc-46
contamination in man, effects of DIPA and EDTA on, 20: 31
use in tracer studies of sand erosion and displacement by surf, 20: 510 (EUR-2167.d)
SCANDIUM OXIDES
$CaO–Sc_2O_3$, phase diagram, 20: 841
$Sc_2O_3–UO_2$, phase diagram, 20: 839
$Sc_2O_3–Y_2O_3$, phase diagram, 20: 840
SCANDIUM SYSTEMS
H–Sc, phase studies and thermodynamics of, 20: 322
SCATTERING
amplitude of forward, univalent functions for analytic properties of, 20: 1065
amplitudes of, integral representations of relativistic, (T), 20: 1053 (JINR-P-2321)
cross sections for radiation damage calculations, approximation of, (T), 20: 901
matrix elements for inelastic, (T), 20: 1054 (JINR-P-2328)
wave packets in nonrelativistic, time delay in, 20: 1067
SCHIFF BASES
complexes with copper(II), spectra of, 20: 289 (TID-21358)
oxidation by *m*-chloroperoxybenzoic acid, kinetics of, 20: 1571(R) (TID-22186)
SCINTILLATION DETECTORS
design for gamma cameras, 20: 668
gamma total absorption in well-type, probability for, 20: 676
performance of liquid, for analysis of antineutrino-proton interactions,

20: 993 (COO-818-70)
pulse pile-up rejection circuitry for gamma spectrometers of, 20: 651 (EGG-1183-2055)
use for CP-5 reactor fuel quality evaluation, 20: 1533 (CONF-650532-2)
SEA WATER
desalination of, using nuclear reactors, 20: 1422
desalination using nuclear reactors, 20: 1481
reactions with sodium, use as hydrogen generator for recovering deeply submerged objects, 20: 1567 (SC-RR-65-380)
strontium-90 uptake from, by *Nerita forsholi* Reclus, 20: 218(R) (STI/DOC/10/42, pp 1-22)
uranium isotope ratio in, from Sagami Bay, Japan, 20: 512
SEALS AND GLANDS
design for reactor moderator block assembly, 20: 1380(P)
design of mechanical coupling, for pressure vessels, 20: 1374(P)
SEED
radiation effects on pea, genetic, 20: 81
radiation effects on growth of seedlings from *Zea mays*, 20: 109
radioinduced chromosome aberrations in, 20: 97
SEEDLINGS
growth of, from irradiated pea seeds, 20: 81
radiation effects on growth of *Zea mays*, from irradiated seed, 20: 109
SEISMIC WAVES
detection of tsunami, operational and support requirements plan for, 20: 543(R) (NVO-98-9)
energy flow from earthquakes and underground atomic explosions, (T), 20: 547
propagation from Bilby underground nuclear explosion, 20: 454
propagation from earthquakes and explosions, 20: 542 (NP-15557)
SELENIUM
vapor pressure, 20: 331
SEMICONDUCTOR DETECTORS
conference, 20: 1345
design and performance of lithium-drifted, for beta and gamma spectroscopy, 20: 664
design for alpha detection and discrimination in aerosols, 20: 691(P)
design for determination of radiation energy and impinging position, 20: 687(P)
neutron reactions (n,α) and (n,p) with silicon-28 at 13.5 to 14.4 Mev in, (E), 20: 1163
performance of gold–silicon, with multi-gard-ring for beta spectroscopy, 20: 665
radiation noise in silicon, measurement of, 20: 693 (NP-15172)
SEMICONDUCTORS
effects on catalysis of radioinduced decomposition of carbon dioxide, 20: 413
fabrication of lithium-drifted silicon p-i-n junctions, 20: 1580(P)
plasma effects in, conference on, 20: 1346
radiation damage in, electron and neutron, 20: 908
radiation effects on, 20: 695
radioinduced defects in germanium and silicon, 20: 904
SENA POWER REACTOR
design and economics, 20: 1480
electric system of, design review, 20: 1507
SEPARATION PROCESSES
transformation theory for rectangular cascade, (T), 20: 448
SEWAGE
treatment by activated sludge plants, effects of radioisotopes on, 20: 218(R) (STI/DOC/10/42, pp 1-22)
SEX
effects on learning capacity of Rhesus monkeys, 20: 92
SHEEP
radiation sickness in, diagnosis of, 20: 128
SHELLS
impact effects on spherical, research program on, 20: 463(R) (SC-DC-65-1634)
SHELTERS
book: *The Architect in the Nuclear Age*, 20: 1577
SHERWOOD PROJECT
magnet refrigeration development, 20: 1265 (NBS-3346)
magnets for, development of cryogenic, 20: 1264 (NBS-8843)
SHIELDED CONTAINERS
design for shipping and handling radioactive materials, 20: 616(P)
SHIELDING
bibliography on, 20: 1305 (AED-C-01-10)
calculations for high energy accelerators, 20: 935 (ORNL-TM-1298)
design for body counters, shadow, 20: 659
dose build-up factor in infinite, for line isotropic gamma source, 20: 1316
materials for reactor environmental test chambers, 20: 478
optical, for thermal radiation, 20: 614
radiosensitivity effects on thymic lymphocytes of adrenal gland and splenic, 20: 142
SHIELDING MATERIALS
cascade showers in high-energy accelerator, 20: 935 (ORNL-TM-1298)
criteria for, 20: 1314
properties and testing of concrete and steel, 20: 1312
radiation transport in, formulation of, (T), 20: 1303 (AD-614250)
SHIPPING
containers for uranium hexafluoride, destructive tests of ten-ton, 20: 593 (KY-500)
of explosives, interstate regulations and permits for safe, 20: 594 (LA-DC-7469)
of radioactive materials, design of container for, 20: 616(P)
SHIPPINGPORT PRESSURIZED WATER REACTOR
power distribution across fuel subassemblies of core 1 seed 4 blanket, thermocouple performance for, 20: 1477 (WAPD-PWR-TE-166)
SHOCK TUBES
design and performance, 20: 619 (AWRE-O-59/65)
flow from open end of rectangular, model study of, 20: 912 (AWRE-O-61/65)
shock velocity in, thin film thermometer for measuring, 20: 618 (AWRE-O-58/65)
SHOCK WAVES
compression of uranium by, dynamic adiabatic curve, 20: 836(T) (UCRL-Trans-1213(L))
effects on hard rocks and underground structures, 20: 496
propagation in conducting incompressible fluids in magnetic fields, (T), 20: 1092
propagation in reactor accidents, computer program for calculating, 20: 1350 (TIM-950)
SILICON
alpha elastic scattering by, distorted-wave model in, (E/T), 20: 1238
determination of traces of, in uranium using electron microprobe, 20: 225 (CONF-650810-2)
preparation for isotopic targets, 20: 696(R) (ORNL-3829)
proton energy losses in single crystals of, axial and planar effects in, (E), 20: 1334
radiation damage in, electron and neutron, 20: 908
radiation noise in detectors of, measurement of, 20: 693 (NP-15172)
radioinduced defects in, 20: 904
vapor pressure, 20: 331
SILICON CARBIDES
deformation properties, 20: 886
SILICON ISOTOPES Si-28
deuteron reactions (d,p) at 1.7 to 3.7 Mev, cross sections for, (E), 20: 1244
neutron reactions (n,α) and (n,p) at 13.5 to 14.4 Mev, cross section for, (E), 20: 1163
proton inelastic scattering at 17.5 Mev, (E), 20: 1192
SILICON JUNCTIONS
fabrication of lithium-drifted p-i-n, 20: 1580(P)
SILICON OXIDES
compatibility with bromine–lead–lead bromin systems at 900°C, 20: 1559 (BNL-9573)
effects on radioinduced polymerization of diphenylvinylphosphine oxide, 20: 408
effects on stabilization of zirconia by calcium oxides, 20: 867
SILICON SYSTEMS
Al–C–Fe–Si–U, radioinduced swelling in, effects of pressure on reactor, 20: 745(R) (BNWL-120, pp 3.1-22)
Al–Fe–Mg–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Mg–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Fe–Ni–Si, corrosion by water and steam, 20: 763 (BNWL-125)
Al–Si, radiation effects on, recovery from neutron-induced, 20: 905
Al–Si, use in bonding aluminum sheaths to uranium fuel elements, 20: 802(P)
SILKWORMS
radiosensitivity of eggs of, 20: 72
SILTS
density of deep-sea, nuclear probe for *in situ* measurements of, 20: 551
desorption of radioiodine from, by air and water, 20: 600 (ORNL-P-1581)
motion of, tracer studies of, 20: 548
SILVER
content in teeth after use in dental restorations, 20: 27
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
properties of, research program on, 20: 1562(R) (NYO-2684-39)
separation from nitric acid by solvent extraction using tri-*n*-octylphosphine sulfide, 20: 244
sorptive properties of particles of, for radioiodine, 20: 216 (CONF-650407, pp 242-75)
SILVER ALLOYS
properties of, research program on, 20: 1562(R) (NYO-2684-39)
SILVER ISOTOPES Ag-109
gamma transition energy of isomeric, (E), 20: 1174

proton reactions (p,n) at 370 Mev, nuclear-structure effects in, (E/T), 20: 1213
SILVER ISOTOPES Ag-111
distribution from nuclear excavation in basalt, 20: 613
SILVER NITRATES
acetonitrile–$AgNO_3$, structure of solutions of, 20: 1565(R) (RPI-1999-6)
benzonitrile–$AgNO_3$, structure of solutions of, 20: 1565(R) (RPI-1999-6)
SINGLE CRYSTALS
grown by pulling from melt, impurity striations in non-rotated antimony–indium, 20: 1573 (TID-22314)
growth for preparation of isotopic targets, 20: 696(R) (ORNL-3829)
SINTERING
of oxide powder compacts, 20: 755(T) (IS-Trans-20)
SKIN
effects of solvents and stable rare earths on rabbit, toxic, 20: 25(R) (TID-22294)
radiation effects in, toxic effects of ultraviolet, 20: 74
radiation effects on sulfhydryl content of rat, uv, 20: 93
radiation injuries of, protection effects of triprolidine for ultraviolet, 20: 132
radioactive contamination of pig, using solutions of radioisotopes, 20: 40
radiosensitivity of, thermal, 20: 614
radiosensitivity of, effects of drugs on uv, 20: 73
SKIN LESIONS
of face, therapy of, 20: 183
pathology of radioinduced, ultraviolet, 20: 74
radiotherapy of, comparison of gamma and x ray sources for, 20: 171
radiotherapy of, design of gamma applicator for, 20: 177
SMOKES
flow around buildings, 20: 562 (CONF-650407, pp 455-9)
polonium-210 content of cigarette, 20: 158
sorptive properties for radioiodine, 20: 216 (CPNF-650407, pp 242-75)
SNOW
water content of, gamma counting of, Fichtelberg, Germany, 20: 550
water deposits in, gamma spectroscopic determination of, 20: 549
SODIUM
boiling of, superheat in, 20: 482 (ORNL-P-1659)
combustion of, studies of variables and fission product release in, 20: 558 (CONF-650407, pp 94-117)
corrosive effects on type 316 stainless steels at 1000°F, 20: 769(R) (NASA-CR-54459)
erosive effects on Cb-132, Stellite 6-B, type 316 stainless steel, T-222, and TZM alloys, 20: 769(R) (NASA-CR-54459)
fission product retention and plating in liquid, studies, 20: 557 (CONF-650407, pp 73-93)
oxygen content in liquid, methods for controlling, 20: 1534(R) (LA-3370)
reactions with sea water, use as hydrogen generator for recovering deeply submerged objects, 20: 1567 (SC-RR-65-380)
SODIUM ACID FLUORIDES
properties for use as fusing agent for decomposition of thorium ore, 20: 333
SODIUM ALLOYS
K–Na, corrosive effects on reactor cooling system materials, 20: 773(R) (ORNL-3859)
K–Na, corrosive effects on boron carbide/stainless steel at 1000°F, 20: 776 (TIM-822)
SODIUM BOROHYDRIDES
hydrolysis of, deuterium isotope effects on, 20: 306
SODIUM CHLORIDES
deformation properties, 20: 886
effects on radioinduced changes in proteins, 20: 49
effects on wholesomeness of radiation processed meat, 20: 700 (AD-621921)
ion self-diffusion mobilities in, determination from tracer transfer rate coefficients, 20: 425
ionic binding of sodium in, determination from tracer transfer rate coefficients, 20: 327
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
SODIUM CHROMATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
SODIUM FLUORIDES
KF–NaF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
LiF–KF–NaF, anodic overvoltages of nickel electrodes in molten eutectic, 20: 284 (EUR-804.e)
SODIUM GRAPHITE REACTORS
steam cycles of, optimization of 350 to 400 Mw(e), 20: 1514
SODIUM GRAPHITE REACTORS
development review, 20: 1513
SODIUM IODIDES
effects on radioinduced changes in proteins, 20: 49
SODIUM IONS
binding in polyelectrolyte solutions, determination from tracer transfer rate coefficients, 20: 327
SODIUM ISOTOPES Na-22
binding of ionic, in polyelectrolyte solutions, 20: 327
exchange in sodium chloride solutions, rate coefficients for, 20: 425
SODIUM ISOTOPES Na-23
deuteron reactions (d,p) at 1.0 to 2.5 Mev, (E), 20: 1185
SODIUM MOLYBDATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
SODIUM NITRATES
effects on wholesomeness of radiation processed meat, 20: 700 (AD-621921)
KNO_3–$NaNO_3$, polarography of oxygen and hydroxyl ions in molten, 20: 285 (EUR-2496.e)
$LiNO_3$–KNO_3–$NaNO_3$, polarography of oxygen and hydroxyl ions in molten, oscillographic, 20: 285 (EUR-2496.e)
SODIUM PERBORATES
magnetic properties, 20: 1571(R) (TID-22186)
SODIUM REACTOR EXPERIMENT
physics experiments in, 20: 1356
SODIUM SELENITES
dielectric properties of partially deuterated single crystals of, dependence on deuterium concentration, (E), 20: 1333
SODIUM TELLURATES
radiolysis in aqueous solutions with nitrous oxide, yields in, 20: 393
SODIUM THIOSULFATES
radiation effects on single crystals of, ESR spectra of free radicals in, 20: 374
SODIUM TUNGSTATES
oxygen-18 exchange between gaseous oxygen and, mechanism and rate of, 20: 422
SODIUM VANADATES
analytical use in amperometric determination of uranyl ions, 20: 255
SOILS
cerium, iron, and manganese uptake by colloids of, 20: 19
density of, design of radiometric equipment for measuring, 20: 623 (NP-15529)
ion exchange properties of, isotope studies, 20: 218(R) (STI/DOC/10/42, pp 1-22)
irrigation control in, neutron probes for, 20: 633
moisture content in, determination by neutron thermalization, 20: 544
moisture content, radioisotope studies of, 20: 548
sorptive properties for cesium, review of selective, 20: 1555
water content in, neutronic method for determining, 20: 632
SOLAR BATTERIES
performance for space applications, 20: 723 (NP-15531)
SOLAR FLARES
effects on geomagnetic fields, (T), 20: 1101
effects on geomagnetic storm sudden commencements, (T), 20: 1107
SOLAR RADIATION
acceleration of corpuscular, in electromagnetic fields, (T), 20: 955
interaction of solar wind with magnetosphere, 20: 1098
SOLIDS
book: *Plasma Effects in Solids*, 20: 1346
diffusion of rare gases in, research program on, 20: 1324(R) (EURAEC-1428)
electron energy level transitions in, (T), 20: 1342
gas–solid, flow and heat transfer in turbulent suspensions, 20: 484(R) (TID-22282)
reduced matrix element of an irreducible spherical tensor operator for, derivation of, 20: 1329
separation from liquids, engineering drawings of drum filter for continuous, 20: 220
SOLUTIONS
electric conductivity of acidic aqueous, role of Grotthuss mechanism in, 20: 340
properties of inorganic salts, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
radiation effects on dilute aqueous, review on mechanism and rate of, 20: 390
radiolysis of aqueous, use in absorption spectroscopy in study of, 20: 63(R) (STI/DOC/10/42, pp 45-55)
research program on nonaqueous ionic, 20: 1565(R) (RPI-1999-6)
SOLVENT EXTRACTION PROCESSES
use of radioisotopes in, calibration curves, optimum conditions, and sensitivity of determinations in, 20: 245
SOUTHWEST AFRICA
radioactivity levels in fossil fuels from, 20: 152(R) (NYO-3086-1 Pt.VIII)

SOVIET UNION
nuclear power plant economics in coordinated networks in, 20: 1488
SOYBEANS
gamma attenuation coefficients for, (E/T), 20: 716
SPACE FLIGHT
effects on man, bibliography on biological, 20: 56 (NASA-SP-7011(15))
propulsion systems for, performance of plasma-jet, 20: 500
radiation effects on biological systems during, 20: 122
SPACE MEDICINE
bibliography on, 20: 56 (NASA-SP-7011(15))
SPACE VEHICLES
electron reactions with Apollo wall sections, bremsstrahlung dose rates and spectra from, 20: 1306 (NASA-TM-X-1140)
heat-shield sublimation and ablation, use of radioisotopes in measuring, 20: 720
materials and structures for, conference on, 20: 877
power plant for, torque production by SNAP-10A, (T), 20: 1528 (NAA-SR-11207)
power supplies for, design of fission-electric cell reactor, 20: 1468 (JPL-TR-32-741)
power systems for, flight performance of SNAP-10A, 20: 1530
propellant gage for, use of krypton-85 in, 20: 721
propulsion of, development and efficiency of plasma-jet engine for, 20: 497(R) (AD-612175)
propulsion of, development of 15-mlb-thrust ion-beam engines for, (E), 20: 498 (NASA-CR-54136)
propulsion of, performance of plasma-jet engines for, 20: 500
propulsion systems for, effects of coherent radiation on stability of electron-beam, (T), 20: 499 (NP-15541)
test of re-entry, during simulated overpressure blast, 20: 462 (SC-DC-65-1554)
use of polyvinyl chloride for coatings on, 20: 384
SPAIN
nuclear power plant development and utilization in, 20: 1576
SPANISH REACTORS (JEN-1)
radiation monitoring equipment for, 20: 1538
SPARK CHAMBERS
development for high-energy particle detection, 20: 649 (BNL-9543)
particle tracks in wire electrode, resolution of ambiguities in, (E/T), 20: 650(R) (COO-614-37, Sect. 2C)
performance as ladder counter for particle momentum analysis, 20: 653 (LAL-1143)
SPECIFIC HEAT
measurement in electrical conductors, pulse heating calorimetric technique for, 20: 827 (ORNL-P-1670)
SPECTROMETERS
performance of spark chamber ladder counter for particle momentum analysis, 20: 653 (LAL-1143)
SPECTROSCOPY
reduced matrix element of an irreducible spherical tensor operator for, derivation of, 20: 1329
SPERMATOGENESIS
radiation effects on mouse, x, 20: 65(R) (TID-22174)
SPHERES
impact effects on hollow, research program on, 20: 463(R) (SC-DC-65-1634)
joining to cylinders, stress-magnitude predictions for, 20: 457(R) (BMI-X-276)
radiation transport in, formulation of, (T), 20: 1303 (AD-614250)
SPINAL CORD
radiation injuries of, induced by radiotherapy of lung carcinoma, 20: 100
SPINELS
thermal properties to melting point, 20: 878
SPLEEN
protective effects of desoxyribonucleic acid extracts from homologous, against radiation injuries in rats, 20: 136
radiation effects on immune reactions to grafts of parental, in rats, 20: 86
radiation effects on mouse, histopathological gamma, 20: 105
radiation effects on thiol content in rat, whole-body, 20: 108
shielding, effects on irradiated thymic lymphocytes of, 20: 142
STABLE ISOTOPES
uses in studying reaction mechanisms of organic compounds, 20: 348
STACK DISPOSAL
activity levels at Elk River Power Reactor, 20: 1547 (CEND-512)
monitoring, 20: 518
monitoring at ERR site, 20: 1452 (ACNP-63628)
processing methods in, fog spray and foam, 20: 1550 (RL-SA-50)
radioactive contamination of atmosphere from fossil-fuel plants, 20: 152(R) (NYO-3086-1 Pt.VIII)
STAINLESS STEEL
brazing of type 347, in joining flanges to sintered filters for use at 1300°F, 20: 786 (ORNL-TM-1252)
cavitation damage of types 304 and 316, in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
corrosion by boiling dichromate–nitric acid, effects of steel composition on, 20: 767(R) (GEAP-4915)
corrosion cracking in austenitic, effects of corrosion media on type of, 20: 767(R) (GEAP-4915)
corrosion cracking in austenitic, factors affecting intergranular, 20: 767(R) (GEAP-4915)
corrosion cracking in sodium at 1000°F of type 316, stress, 20: 769(R) (NASA-CR-54459)
corrosion of 316 and 347, by liquid potassium–sodium in test loops, 20: 773(R) (ORNL-3859)
degasification of type 304, by electron bombardment, 20: 915 (ORNL-TM-1166)
erosion by sodium at 400, 1000, and 1500°F of type 316, 20: 769(R) (NASA-CR-54459)
fatigue in sodium at 1000 and 1500°F of type 316, high-frequency, 20: 769(R) (NASA-CR-54459)
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
oxidation by steam of type 304, effects of surface work-hardening on, 20: 765(R) (EURAEC-1387)
oxidation by steam at 500°C of type 304, effects of surface finishing on, 20: 766(R) (EURAEC-1445)
oxidation by water of type 304, effects of surface finish on, 20: 765(R) (EURAEC-1387)
oxidation by water of type 410, effects of surface finish on, 20: 766(R) (EURAEC-1445)
oxidation by water of type 304, effects of flow rate on, 20: 766(R) (EURAEC-1445)
radiation effects on creep in type 304, neutron, 20: 889(R) (BNWL-120, pp 4.1-59)
radiation effects on ductility of types 304 and 348, fast neutron, 20: 889(R) (BNWL-120, pp 4.1-59)
radiation effects on embrittlement of type 304, effects of boron on, 20: 898
radiation effects on 304, electron and uv, 20: 910
radioinduced reactions with urania, 20: 1465(R) (GEAP-4894)
reactions of type 316, with boron carbide in potassium–sodium alloy at 1000°F, 20: 776 (TIM-822)
reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
sorptive properties for fission-product iodine from various environments, 20: 574 (CONF-650407, pp 730-46)
strengthening mechanisms in austenitic and ferritic, 20: 817 (CONF-710)
stress-hydrogen cracking of Type 410, 20: 772 (NYO-3257-1)
welding of austenitic, control standards, radiographic techniques and specifications for, 20: 800
PuO_2–stainless steel–UO_2, analysis of cermets of, for plutonium, 20: 222 (AERE-R-4975)
STANFORD LINEAR ACCELERATOR
beam interactions with laser beam, monochromatic gamma beam production in, (E/T), 20: 936 (SLAC-41)
development, Jan.-March 1965, 20: 937(R) (SLAC-45)
STARS
energy transport in, boundary of convective, (T), 20: 954
evolution and structure of helium, numerical models of, 20: 958
gravitational collapse of, scalar wave interactions with Schwarzschild metric in, 20: 957
STATISTICS
correlation functions in classical statistical mechanics, (T), 20: 1082 (COO-720-053)
STEAM
corrosive effects on high-silicon aluminum alloys, 20: 763 (BNWL-125)
corrosive effects on type 304 stainless steel, effects of surface finish on, 20: 766(R) (EURAEC-1445)
corrosive effects on type 304 stainless steel, effects of surface work-hardening on, 20: 765(R) (EURAEC-1387)
effects on fission product release from melted stainless-steel clad uranium dioxide fuel elements, 20: 559 (CONF-650407, pp 276-91)
reactions with zirconium in loss-of-coolant reactor accident calculations, 20: 582 (CONF-650407, pp 938-69)
sampling of reactor, instrumentation for, 20: 1466(R) (HPR-63)
air–steam, fission product removal by steam suppression system, 20: 576 (CONF-650407, pp 776-804)
steam–water, critical flow, (T), 20: 488
STEAM ENGINEERING
cycle optimization for 350 to 400-Mw(e) sodium graphite reactors, 20: 1514
STEEL
analysis for yttrium by solution spectrographic method, 20: 266
cooling transformation characteristics of A302B, 20: 833 (WERL-8844-5)
embrittlement in, hardness measurements for detection of, 20: 860
failure of pressure vessel, study of delayed, 20: 889(R) (BNWL-120,

pp 4.1-59)
gamma transmission through pipe walls of, thickness dependence of, (T), 20: 1320
iodine deposition on, from vapor phase, 20: 215 (CONF-650407, pp 142-77)
microstructure of A302B, 20: 833 (WERL-8844-5)
oxidation by water of Creusot 1.2 MD 07 boilerplate, effects of flow rate on, 20: 765(R) (EURAEC-1387)
plastic deformation of ferritic lamellar-pearlite, identification of kink bands in, 20: 835(T) (AERE-Trans-1035)
production and properties of high-strength martensitic, by cyclic transformation of austenite, 20: 754 (UCRL-16121)
properties as reactor material, 20: 1312
properties of skin and heart of Super Elso, 20: 818 (EURAEC-1348)
radiation effects on pressure vessel, 20: 1352(T,R) (JPRS-31526)
radiation effects on stressed, device for investigating in-pile, 20: 1385(P)
reactions with oxygen, equilibrium oxygen pressures produced in, 20: 277 (AERE-R-4942)
strengthening mechanisms in austenitic and ferritic, 20: 817 (CONF-710)

STELLARATORS
plasma containment by, instabilities in, (T), 20: 1260 (MATT-370)

STERILITY
radioinduced in mice, x, 20: 65(R) (TID-22174)

STERILIZATION
techniques for virus isolation by zonal centrifugation, 20: 7(R) (ORNL-3883)

STIRRING APPARATUS
design for feed-sampling tank, engineering drawings for, 20: 342
design of magnetic, for diffusion cells, engineering drawings for, 20: 221

STOMACH
radiation effects on ultrastructure of gastric fundus glands in mouse, 20: 111

STRATOSPHERE
fallout transport in, meteorological factors in, 20: 523

STRESS ANALYSIS
collapse pressure for cylindrical-spherical pressure vessels, 20: 465
effects of nozzles in spherical pressure vessels, 20: 1364
of hemispherical pressure vessel with single radially attached nozzle, computer program for, 20: 459 (ORNL-3817)
of normally intersecting cylindrical shells, 20: 466
of rotating disks, (T), 20: 467
of tape-wound magnet coils, (T), 20: 1264 (NBS-8843)
strain determination using moire fringe technique, 20: 1574 (UCRL-13156)
stress concentrations in nozzle rings of pressure vessels, 20: 1365

STRESS CORROSION
mechanisms of transgranular cracking due to, 20: 779

STRONTIUM
content in chondrites and chondrules, age estimation from, 20: 529
determination in reactor waters, spectrochemical, 20: 256
determination of, in presence of calcium, x-ray fluorescent, 20: 232(R) (NYO-901-37, pp 80-4)
effects on crystal structure of bone, 20: 232(R) (NYO-901-37, pp 80-4)
metabolism in animals, effects of dietary phosphates on, 20: 8(R) (STI/DOC/10/42, pp 23-43)
separation from low-level waste water, 20: 1549 (ORNL-3811)
separation of radio-, from Clinch River water using treatment plant, 20: 592 (K-C-785)

STRONTIUM CARBIDES
preparation and properties of di-, 20: 810 (AERE-R-5011)
vaporization of, 20: 810 (AERE-R-5011)

STRONTIUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)

STRONTIUM HYDROXIDES
bond energy of SrOH, 20: 294(T) (UCRL-Trans-1239(L))

STRONTIUM ISOTOPES Sr-85
content in human urine following intravenous injection, method for estimating strontium-90 burdens using, 20: 32
excretion by kidneys of dogs, 20: 30
use in studies of bone growth, 20: 8(R) (STI/DOC/10/42, pp 23-43)

STRONTIUM ISOTOPES Sr-86
content in chondrites and chondrules, age estimation from, 20: 529

STRONTIUM ISOTOPES Sr-87
content in chondrites and chondrules, age estimation from, 20: 529
content in igneous and metamorphic rocks, Llano Uplift, Texas, 20: 532

STRONTIUM ISOTOPES Sr-89
content and distribution in suspended matter in seaweed, 20: 612
content in food and milk from EURATOM countries, 1963, 20: 144 (EUR-2460.d,f,i,n)
content in milk, in Germany, 20: 524
distribution from nuclear excavation in basalt, 20: 613

STRONTIUM ISOTOPES Sr-90
body burdens in man, review of methods for estimating, 20: 32
content in diet of human infants, 20: 521(R) (HASL-164)
content in food and milk from EURATOM countries, 1963, 20: 144 (EUR-2460.d,f,i,n)
content in milk, 20: 596 (NP-15542)
content in milk, 20: 597 (NP-15563)
content in milk, in Germany, 20: 524
content in natural and processed materials in Australia, 20: 156
content in upper layers of coastal sediments of Ligurian Sea, 20: 526
determination by autoradiography using ring-oven method, temperature effects on fading effect in, 20: 251
determination in biological materials, radiochemical, 20: 218(R) (STI/DOC/10/42, pp 1-22)
distribution from nuclear excavation in basalt, 20: 613
effects on serum lactic dehydrogenase levels in beagles, by internal deposition, 20: 112
fallout in Australia, meteorological factors, 20: 523
material balance of, 20: 521(R) (HASL-164)
metabolism in lactating rats, 20: 35
performance in thermoelectric generators, 20: 723 (NP-15531)
radiochemical analysis, 20: 417(R) (NYO-3086-1 Pt.IX)
uptake and release of, in *Nerita forskali* Recluz in seawater, 20: 218(R) (STI/DOC/10/42, pp 1-22)
use in beta irradiator for high-pressure high-temperature chemical reactions, 20: 355(R) (NYO-2978-42)
uses as power source for underwater acoustic beacon, 20: 726

STRONTIUM OXIDES
Dy_2O_3–SrO, phase studies, 20: 302
Er_2O_3–SrO, phase studies, 20: 302
Eu_2O_3–SrO, phase studies, 20: 302
Gd_2O_3–SrO, phase studies, 20: 302
Ho_2O_3–SrO, phase studies, 20: 302
La_2O_3–SrO, phase studies, 20: 302
Lu_2O_3–SrO, phase studies, 20: 302
Nd_2O_3–SrO, phase studies, 20: 302
Pr_2O_3–SrO, phase studies, 20: 302
Sm_2O_3–SrO, phase studies, 20: 302
SrO–Th_2O_3, phase studies, 20: 302
SrO–Tm_2O_3, phase studies, 20: 302
SrO–Yb_2O_3, phase studies, 20: 302

STRONTIUM SULFIDES
rare earth sulfides–SrS, crystal structure of solid solutions in, 20: 332

STRONTIUM TITANATES
use of strontium-90-enriched, in beta irradiator for high-pressure high-temperature chemical reactions, 20: 355(R) (NYO-2978-42)

STYRENE
effect on radioinduced polymerization of methyl acrylate in ethyl chloride, 20: 404
radioinduced polymerization with methyl acrylate in ethyl chloride at −78°C, 20: 404
radioinduced polymerization with methyl acrylate in ethyl chloride at 0 to −78°C, 20: 404
butadiene–styrene, radioinduced graft polymerization with cotton or rayon, 20: 363

STYRENE POLYMERS
radioinduced graft polymerization of acrylonitrile on, 20: 401

SUCCINIC ACID
radiation effects on single crystal β-, EPR spectra of, 20: 389

SULFATE IONS
effects on electron exchange between uranium(IV) and uranium(VI), tracer studies of, 20: 296

SULFONAMIDES
effects on skin photosensitivity, uv, 20: 73

SULFONATES
effects on ethyl methane sulfonate, on pea seeds, 20: 81
protective effects of sodium cysteinethiosulfate, against radiation injuries of sarcomas in mice, 20: 131

SULFUR
colloids, effects on radioinduced changes in aqueous polymer solutions, tracer study, 20: 137
spectra of, effects of chemical bonding on x-ray, 20: 291 (UCRL-14379)

SULFUR COMPOUNDS
sulfur x-ray spectra in, chemical bonding effects on, 20: 291 (UCRL-14379)

SULFUR DIOXIDES
reactions with plutonium and uranium hexafluorides, 20: 445

SULFUR ISOTOPES
effects on decomposition of thiosulfate, 20: 297

SULFUR ISOTOPES S-32
neutron reactions (n,p) with, use in criticality dosimeter, 20: 647 (AERE-M-1631)

SULFUR ISOTOPES S-34

proton reactions (p,αy) (n ≥ 2) with, correlations from, (E), 20: 1146 (COO-1120-38)
SULFUR ISOTOPES S-35
detection and measurement of, by 4π gas counter, 20: 666
effects on efficiency of activated sludge plants for sewage treatment, 20: 218(R) (STI/DOC/10/42, pp 1-22)
SULFURIC ACID
radiation effects on oxidation of, dose rate effects on gamma and x-ray, 20: 412
separation from aqueous solutions containing metal values, method for, 20: 1578(P)
solvent partition between aqueous and organic phases of aliphatic amines in kerosene and xylene, 20: 223 (CEA-R-2760)
Fe–isobutylol–O–H_2SO_4–H_2O, radioinduced oxidation and reduction reactions of iron ions in, 20: 388
SUN
activity of, data tabulation for July–Dec. 1964, 20: 1108
charged-particle acceleration in electromagnetic fields of, (T), 20: 955
spectra from, highly ionized atomic, 20: 341
SUPERCONDUCTIVITY
nucleation in wedge geometry, (T), 20: 1123
theory of, criteria for Bogoliubov quasiparticles in, 20: 1126
SUPERCONDUCTORS
critical current density in hard alloy, method for increasing, (E), 20: 1121(T) (AI-Trans-97)
critical temperature of impure, effect of resonance scattering on, 20: 1127
critical temperature of niobium-transition metal, 20: 1129
flux penetration in cylindrical films of, 20: 1128
magnetic flux annihilation and instabilities in inhomogeneous, (E), 20: 1132
penetration depth in niobium, temperature variation of, (E), 20: 1131
performance in magnets, 20: 1120(R) (ORNL-3836, pp 90-110)
properties of Nb_3Sn, (T), 20: 1264 (NBS-8843)
properties of thin film, Ginzburg-Landau theory for, 20: 1264 (NBS-8843)
uses in magnets for measuring hyperon (Ξ^-) magnetic moment, (E), 20: 990 (BNL-9490)
uses in minimum-B magnets for plasma containment, (E), 20: 1279 (UCRL-14233)
SUPERFLUIDITY
flow of liquid helium II through narrow channels, (E), 20: 1119 (LA-DC-7357)
SUPERHEATERS (NUCLEAR)
design, 20: 1519(P)
design, 20: 1522(P)
design, 20: 1523(P)
design of Russian, 20: 1351 (WASH-1060)
design of 300- and 1000-Mw(e) graphite, 20: 1515
development review, 20: 1513
fuel element cladding for, properties of Incoloy 800 as, 20: 907
heat exchanger support structure for, 20: 1525(P)
SURFACE WATERS
age estimation of carbonates from Lake Bonneville and Lake Lahontan, Great Basin, 20: 546
determination in snow by gamma counting, Fichtelberg, Germany, 20: 550
deuterium, oxygen-18, and tritium contents of, in karst region, Turkey, 20: 538
transport of, tracer studies of, 20: 548
SURFACES
degasification of metal, by electron bombardment, 20: 915 (ORNL-TM-1166)
phase boundaries, optical techniques for study of, 20: 290 (UCRL-11997)
SURGERY
tissue reactions to radiosterilized sutures in, 20: 712
use for metastatic cancers in lymph nodes, 20: 212
SUSPENSIONS
flow and heat transfer in turbulent gas–solid, research program on, 20: 484(R) (TID-22282)
SWAGING
design of die for high-temperature, of tungsten cylinders *in vacuo*, 20: 781 (AI-65-12)
SWEDISH REACTORS (R-0)
experimental facilities of, design and use of, 20: 1540
SWEDISH REACTORS (R-2)
experimental facilities of, design and use of, 20: 1540
SWEDISH REACTORS (R-3)
design and performance, 20: 1485
SWIMMING POOL REACTORS
design of, with improved cooling system, 20: 1370(P)
fission gas release in, collecting device for, 20: 1544(P)
SWINE
contamination of skin of, using solutions of radioisotopes, 20: 40
radiation sickness in, diagnosis of, 20: 128
SYNCHROTRONS
beam switching magnets for, design of nsec ferrite-core, (E), 20: 939 (UCRL-16364)
phase oscillations in, resonance of, (E/T), 20: 941
SYSTEMS FOR NUCLEAR AUXILIARY POWER
design and performance as thermoelectric generators, 20: 723 (NP-15531)
design of, engineering drawings for, 20: 717
heat transfer in reactors, model for simulating, (T), 20: 1529 (NAA-SR-Memo-10961)
launch success of isotope-fueled, probability of, (T), 20: 725
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-2)
destructive test SNAPTRAN 2/10A-3, fission product release and dispersion from, 20: 564 (CONF-650407, pp 512-36)
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-8)
cooling system materials for, corrosion by liquid potassium–sodium, 20: 773(R) (ORNL-3859)
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-9)
plutonium-238 contamination from, 20: 521(R) (HASL-164)
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-10)
destructive test SNAPTRAN 2/10A-3, fission product release and dispersion from, 20: 564 (CONF-650407, pp 512-36)
magnetic moments and vehicle torques in 10A, (T), 20: 1528 (NAA-SR-11207)
performance of 10A, in flight, 20: 1530
thermal expansion compensators for 10A, design and testing of, 20: 1527 (NAA-SR-9778)
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-15)
hazards analysis of 15A, 20: 722 (GA-4554(Rev.))

T

TANKS
design of feed-sampling, engineering drawings for, 20: 342
tests of shipping containers for uranium hexafluoride, destructive, 20: 593 (KY-500)
TANTALUM
carburization for fuel capsules, methods of, 20: 1534(R) (LA-3370)
determination in niobium by electron excitation, x-ray spectrographic, 20: 246
dislocation motion at low temperatures, mechanism, 20: 819(R) (GA-6413)
etching dislocations on oriented single-crystal faces of, 20: 866
gamma scattering by K-shell electrons, cross sections for incoherent, 20: 978
hardening in single-crystal, strain and temperature effects on, 20: 837
melting of, composition of gases evolved during electron beam, 20: 872
oxidation at high temperatures and low oxygen potentials, model for, (T), 20: 780
proton spallation reactions at 660 Mev, gadolinium-149 production in, (E), 20: 1220
reactions with molten cerium–cobalt–plutonium alloys, 20: 1534(R) (LA-3370)
solubility in plutonium at 700 to 950°C, 20: 1534(R) (LA-3370)
testing for molten plutonium fuel container, 20: 1534(R) (LA-3370)
thermal conductivity of, at 800 to 2200°C, 20: 823 (LA-DC-7456)
vapor pressure, 20: 331
vaporization of, under vacuum and forced convection conditions, (T), 20: 831 (UCRL-14274)
TANTALUM ALLOYS
Ga–Ta, crystal structure of intermetallic compounds in, 20: 871
Hf–Ta–W, cavitation damage of T-111 in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
Hf–Ta–W, thermal properties to melting point, 20: 878
Nb–Ta–V, thermal properties to melting point, 20: 878
Nb–Ta–W–Zr, thermal properties to melting point, 20: 878
Ta–W, carburization for fuel capsules, methods for, 20: 1534(R) (LA-3370)
Ta–W, testing for molten plutonium fuel container, 20: 1534(R) (LA-3370)
Ta–W, thermal properties to melting point, 20: 878
Ta–W–Y, carburization for fuel capsules, methods for, 20: 1534(R) (LA-3370)
TANTALUM BROMIDES
derivatives of, preparation and properties of oxidized, 20: 337
TANTALUM CARBIDES
extrusion of, development of techniques for, 20: 796
TANTALUM CHLORIDES
derivatives of, preparation and properties of oxidized, 20: 337
TANTALUM ISOTOPES Ta-181
energy levels, (E), 20: 1177
energy levels of, lifetime of, (E), 20: 1175

TANTALUM SYSTEMS
C–Hf–Ta–W, cavitation damage of T-222 in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
C–Hf–Ta–W, erosion by sodium at 400, 1000, and 1500°F of T-222, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–Ta–W–Zr, erosion by sodium at 400, 1000, and 1500°F of Cb-132M, 20: 769(R) (NASA-CR-54459)
TARTARIC ACID
effects on disproportionation of uranium(V), kinetics of, 20: 328
effects on oxidation and reduction of uranium ions in perchloric acid, disproportionation, 20: 326
effects on uranium(IV) oxidation by thallium(III) in aqueous perchloric acid, 20: 319
TASTE
alteration in irradiated fish, effects of hypoxanthine on, 20: 718
TECHNETIUM ALLOYS
Tc–W, structure of arc-melted, 20: 814(R) (BNWL-142)
TECHNETIUM ISOTOPES Tc-99
energy levels of, lifetime of, (E), 20: 1175
use in hepatic scintillography, 20: 197
TECHNOLOGY
transfer of non-nuclear, to industry, 20: 1564 (ORO-629)
TEETH
analysis for trace elements in, neutron activation, 20: 27
content of trace elements in, effects of metal restorations on, 20: 27
radiography of, radiation hazards from diagnostic, 20: 198
radium-226 and -228 content in Brazilian, 20: 150(R) (NYO-3086-1 Pt.VI)
TELEMETERING SYSTEMS
use of distributed-carrier multiplex, for control of CERN accelerators, 20: 933 (CERN-65-28)
TELLURITE IONS
yields in gamma radiolysis of aqueous nitrous oxide-sodium tellurite solutions, 20: 393
TELLURIUM
separation from antimony by extraction chromatography, 20: 433 (INP-412/C)
vapor pressure, 20: 331
TELLURIUM ISOTOPES Te-120
energy level structure, (E), 20: 1173
TELLURIUM ISOTOPES Te-122
energy level structure, (E), 20: 1173
TELLURIUM ISOTOPES Te-131
beta decay of isomeric, gamma spectra in, (E), 20: 1201
TEMPERATURE
distribution in nucleate boiling of subcooled fluid, (T), 20: 485(T) (ANL-Trans-225)
effects on free radical formation in irradiated nucleic acids and nucleotides, 20: 421
effects on hydrogen yields in radiolysis of methane and propane, 20: 381
measurement in reactor fuel channels, device for, 20: 1368(P)
TEMPERATURE CONTROL
system for, in medium volume chambers, 20: 625 (SC-TM-65-268)
TERBIUM
determination of, in rare-earth mixtures, photometric, 20: 252
Seebeck effect in single crystals of, (E), 20: 1343
separation from uranium by extraction chromatography, 20: 433 (INP-412/C)
thermal hysteresis of magnetic transitions in polycrystalline, 20: 851
TERBIUM OXIDES
SrO–Th_2O_3, phase studies, 20: 302
TEREPHTHALIC ACID
Al–polyethylene terephthalate, radiation effects of electrons on capacitors of, (E), 20: 692 (NASA-CR-312)
TERPENES
radiation effects on stability of, 20: 713
TERPHENYL
corrosive effects on iron in presence of chlorine and water, 20: 777
radiolysis of, comparison of gamma and fast-neutron, 20: 356 (SGAE-CH-19/1965)
solvent properties for iron chlorides, 20: 777
TETRACYCLINE
effects on skin photosensitivity, uv, 20: 73
TEXAS
age estimation of igneous and metamorphic rock of Llano Uplift in, 20: 532
TEXTILES
analysis using activation, 20: 238(T) (NP-tr-1293)
radioinduced crosslinking of regenerated cellulose, with N-methylol compounds, 20: 358(T) (NP-tr-1299)
radioinduced graft polymerization of rayon with acrylonitrile, butadiene, and styrene, properties of products in, 20: 363
THALLIUM
electron plasma resonances in, analysis using photon scattering, (T), 20: 1326 (ORNL-P-1600)
THALLIUM FLUORIDES
spectra of, rotational, (E), 20: 1327
THALLIUM IONS
effects on oxidation of uranium(IV) in aqueous perchloric acid, effects of tartaric acid on kinetics of, 20: 319
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
THALLIUM ISOTOPES Tl-197
hyperfine structure and isotope shift, (E), 20: 1245
THALLIUM ISOTOPES Tl-198
spectra of, isotope shift in, (E), 20: 1245
THALLIUM ISOTOPES Tl-203
internal conversion of, penetration effects in, (T), 20: 1181
mass from rotational spectra of thallium fluoride, (E), 20: 1327
THALLIUM ISOTOPES Tl-204
detection and measurement of, by 4π gas counter, 20: 666
determination by autoradiography using ring-oven method, temperature effects on fading effect in, 20: 251
THALLIUM ISOTOPES Tl-205
mass from rotational spectra of thallium fluoride, (E), 20: 1327
spectra of, isotope shift in, (E), 20: 1245
THERMAL CONDUCTIVITY
measurement at high temperatures, pulse technique for, using laser, 20: 823 (LA-DC-7456)
THERMAL DIFFUSION
in gases and gas mixtures, research program on, 20: 963(R (TID-22313)
THERMAL RADIATION
dose measurements of, in human skin, 20: 614
effects of nuclear explosion, biological, 20: 614
effects on irradiated glass, luminescence, 20: 382
emission by plasma, fluctuations of, (T), 20: 1293
flux of, comparison of calorimeters and radiometers for measuring, 20: 624 (SC-DC-65-1507)
THERMIONIC CELLS
design and operation of auxiliary discharge, operating in Gabor mode, (E/T), 20: 989
development, (E/T), 20: 1534(R) (LA-3370)
THERMOCOUPLES
calibration of, in-pile, 20: 1466(R) (HPR-63)
design as integrated neutron flux indicator, 20: 684(P)
design of fine wire, for subdermal temperature measurements, 20: 614
performance of Alumel/Chromel, for analysis of PWR-1 seed 4, 20: 1477 (WAPD-PWR-TE-166)
THERMODYNAMICS
correlation functions in classical statistical mechanics, (T), 20: 1082 (COO-720-053)
entropy production integral in, convergence of iterative solution of, (T), 20: 1083 (MATT-368)
vaporization of nuclear materials at high temperatures, 20: 283 (COO-1140-129)
THERMOELECTRIC CELLS
design and performance of isotope-fueled, for space applications, 20: 723 (NP-15531)
performance with lunar nuclear power plants, 20: 1516
THERMOELECTRIC PROPERTIES
of potassium at high temperatures, 20: 286 (NRL-6233)
THERMOLUMINESCENT DETECTORS
use in radiation dosimetry, review on, 20: 656
THERMOMETERS
design of acoustic, 20: 1534(R) (LA-3370)
THERMONUCLEAR EXPLOSIONS
fallout, effects in Marshallese population ten years post-exposure, 20: 90
thermal radiation dose from, 20: 614
THERMONUCLEAR REACTIONS
magnetic-field and temperature effects on, 20: 1275(R) (ORNL-3836, pp 117-19)
THERMONUCLEAR REACTORS
development, 20: 1268(R) (ORNL-3836)
magnet refrigeration systems for, performance of pulsed, 20: 1263 (NBS-8817)
plasma heating in ELMO and EPA, by electron cyclotron effects, 20: 1271(R) (ORNL-3836, pp 33-5)
spectra from, highly ionized atomic, 20: 341
tritium chemistry and control in, 20: 1274(R) (ORNL-3836, pp 111-16)
THICKNESS GAGES
accuracy of beta-backscatter and x-ray-emission, 20: 493
THIOLS
radiation effects on content of, in rat liver and spleen, 20: 108
THIOSULFATES
decomposition of, isotope effects on, 20: 297
THORIUM
effects on chromosome patterns in man, chronic exposure, 20: 60(R) (NYO-901-37, pp 33-68)

fission gas release from irradiated carbon-coated particles of, 20: 899
production by magnesium–zinc reduction of dioxide, 20: 742 (ANL-7058)
separation from neptunium, plutonium, and uranyl nitrate solutions by ion exchange and solvent extraction, 20: 242
separation from rare earths and uranium, chromatographic, 20: 449
vapor pressure, 20: 331

THORIUM ALLOYS
Pu–Th, separation of plutonium from, by Lamex process, 20: 443
Th–U, extrusion of Zircaloy-2-clad fuel tubes of, 20: 782 (DP-943)
Th–U, radioinduced swelling of Zircaloy-2-clad fuel tubes of, reactor, 20: 782 (DP-943)

THORIUM CARBIDES
fabrication of spherical particles of, by powder agglomeration method, 20: 793

THORIUM CARBONATES
yields from thermal decomposition of thorium oxalate, 20: 317

THORIUM(IV) FLUORIDES
reduction by liquid magnesium–zinc alloy, 20: 742 (ANL-7058)

THORIUM IONS
exchange on phosphonate resin Bio-Rex 63, kinetics of, 20: 263

THORIUM ISOTOPES Th-226
testing sealed sources of, leak, 20: 601 (RCC-R-176(Add.))

THORIUM ISOTOPES Th-228
content in bones of radium dial painters, 20: 22(R) (NYO-3086-1 Pt.II)
content in dog bones following injection, 20: 23(R) (NYO-3086-1 Pt.III)
decay in beagles, metabolism of bismuth-212, lead-212, and radium-224 from, 20: 42
effects on serum lactic dehydrogenase levels in beagles, by internal deposition, 20: 112
testing sealed sources of, leak, 20: 601 (RCC-R-176(Add.))

THORIUM ORES
decomposition of, properties of ammonium, potassium, and sodium hydrogen fluorides as fusing agents for, 20: 333

THORIUM OXALATES
thermal decomposition of, in vacuum, 20: 317

THORIUM OXIDES
fabrication of spherical particles of, by powder agglomeration method, 20: 793
yields from thermal decomposition of thorium oxalate, 20: 317

THORIUM(IV) OXIDES
crystal growth studies of, (E), 20: 287 (ORNL-P-1611)
effects on tumor induction in human liver, 20: 123
neutron resonance integrals for, temperature-dependent, (T), 20: 1148 (CRRP-1222)
reduction by liquid magnesium–zinc alloy, 20: 742 (ANL-7058)
Sc_2O_3–ThO_2, phase diagram, 20: 839
ThO_2–Y_2O_3, defect structure and electric conductivity of, 20: 843
ThO_2–Y_2O_3, phase relations and solid solubility in, 20: 843

THORIUM RESERVES
estimates of free-world, 20: 552 (NP-15534)

THRESHOLD DETECTORS
design for fast neutrons, 20: 681(P)
performance for fast neutron spectroscopy, 20: 1304 (AE-196)
uses for neutron spectroscopy in reactors, 20: 1414

THULIUM
determination of, in rare-earth mixtures, photometric, 20: 252
thermal hysteresis of magnetic transitions in polycrystalline, 20: 851

THULIUM ISOTOPES Tm-169
internal conversion coefficient from Mössbauer scattering, (E), 20: 1251
neutron reaction (n,γ) with, conversion electrons from, (E), 20: 1223

THULIUM ISOTOPES Tm-170
energy level transitions from conversion electrons in thulium-169 (n,γ) reactions, 20: 1223

THULIUM OXIDES
SrO–Tm_2O_3, phase studies, 20: 302

THYMIDINE
effects of carbon-14 or tritium labeled, carcinogenic, 20: 66 (TID-22292)
metabolism in desoxyribonucleic acid of human leukemia cells, tracer study, 20: 20 (EUR-2451.e)

THYMINES
radioinduced free radicals in, ESR spectroscopy of, 20: 421

THYMUS GLAND
effects of radiation on phagocytic activity of cells of rat, in tissue culture, 20: 85
protective effects of desoxyribonucleic acid extracts from homologous, against radiation injuries in rats, 20: 136
radiation effects on lymphocytes in, effects of adrenal gland and splenic shielding on, 20: 142

THYROID GLAND
cancers of, etiology, pathology, and therapy, 20: 203
iodine content of, in euthyroid patients, tracer study, 20: 36
iodine-131 effects on mouse, pathological and physiological, 20: 62(R) (NYO-901-37, pp 74-9)
iodine-131 metabolism in, of children with goiter, 20: 185
radiodiagnosis of diseases of, use of iodine-131 for, 20: 207
radioinduced tumors of, incidence of, 20: 203
radiotherapy of hyperthyroidism, use of iodine-131 for, 20: 181
radiotherapy of malignancies of, using iodine-131, 20: 196
radiotherapy of tumors of, using iodine-131, 20: 203

THYROXINE
excretion of iodine in, in euthyroid patients, tracer study, 20: 36

TIN
gamma scattering by K-shell electrons, cross sections for incoherent, 20: 978
helium-3 elastic scattering at 29 Mev, polarization in, (T), 20: 1171
vapor pressure, 20: 331

TIN ALLOYS
Ce–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Cu–Sn, production of needle-like Cu_6Sn_5 crystals in matrix of, 20: 760
In–Sn, Mössbauer effect near melting point, 20: 862
La–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Nb–Sn, superconductivity of Nb_3Sn, (T), 20: 1264 (NBS-8843)
Nd–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Pb–Sn, Mössbauer effect near melting point, 20: 862
Pr–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Sb–Cu–Sn, Mössbauer effects near melting point, 20: 862
Sm–Sn, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Sn–Ti, crystal structure of intermetallic compounds in, 20: 871
Sn–U, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861

TIN COMPOUNDS
Mössbauer spectra of, isomer shifts and quadrupole splittings of, (E), 20: 1335

TIN ISOTOPES
proton reactions (p,n) at 6 to 14 Mev, neutron spectra from, (E/T), 20: 1239

TIN ISOTOPES Sn-119
Mössbauer effect in tin compounds, (E), 20: 1335

TISSUE CULTURES
radiation effects on growth of glioblastoma cells in, 20: 101
radiation effects on nucleic acid and phosphate metabolism in carrot, effects of dose-rate on x, 20: 120
radiation exposure of single cells in, 20: 58(R) (NYO-901-37, pp 14-30)
radiosensitivity of chromosomes of leukocytes in, 20: 88
use of canine, for isolation of viruses from dogs, 20: 4 (LF-26)

TISSUES
cesium-137 content in guinea pig, following injection by different routes, 20: 33
radiation effects on immune reactions to transplanted, 20: 104
rare earths in, residue studies of, 20: 25(R) (TID-22294)

TITANIUM
degasification by electron bombardment, 20: 915 (ORNL-TM-1166)
effects on spectrographic determination of yttrium in steel, 20: 266
isomer shift as function of pressure, Mössbauer effect for, (E), 20: 1344
vapor pressure, 20: 331

TITANIUM ALLOYS
Mo–Ti, cavitation damage in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
Mo–Ti–Zr, erosion by sodium at 400, 1000, and 1500°F of TZM, 20: 769(R) (NASA-CR-54459)
Mo–Ti–Zr, fatigue behavior at high temperatures in ultrahigh vacuum, 20: 824(R) (NASA-CR-54458)
Mo–Ti–Zr, fatigue in sodium at 1000 and 1500°F of TZM, high-frequency, 20: 769(R) (NASA-CR-54459)
Mo–Ti–Zr, thermal properties to melting point, 20: 878
Nb–Ti–Zr, thermal properties to melting point, 20: 878
Sn–Ti, crystal structure of intermetallic compounds in, 20: 871

TITANIUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)

TITANIUM NITRIDES
TiN–UN, fabrication of fuels of, 20: 803(P)

TITANIUM OXIDES
effects on stabilization of zirconia by calcium oxides, 20: 867
sintering of powders of, 20: 755(T) (IS-Trans-20)

TITRATION EQUIPMENT
design of automated potentiometric, for determination of plutonium, 20: 222 (AERE-R-4975)

TOBACCO
cesium-137, potassium-40, radium-226, and strontium-90 contents in, in Australia, 20: 156

polonium-210 content in smoke of cigarette, 20: 158
radioisotope uses in industry of, 20: 706
TOKAI-MURA POWER REACTOR
electric system of, design review, 20: 1507
fuel development and performance for, 20: 1496
TOLUENE
effects on radiolysis of monoimine of phenanthrene-9,10-quinone, 20: 397
tritium exchange with water, 20: 347(R) (TID-22251)
TOMATOES
radiation effects on nucleic acid and phosphate metabolism in, effects of dose-rate on x, 20: 120
TOXICITY
effects of solvents and stable rare earths on rabbit skin, 20: 25(R) (TID-22294)
TOXINS
radiation effects on production of *Clostridium botulinum*, in packaged fish, 20: 707
TRACER TECHNIQUES (BIOLOGY)
autoradiographic, contrast factors for, 20: 13
DNA labeling, use in granulocytopoiesis studies, 20: 1 (BNL-9363)
TRACER TECHNIQUES (BOTANY)
for plant metabolism in cuttings propagated under mist, 20: 21 (NYO-2598-25)
TRACER TECHNIQUES (CHEMISTRY)
development for determining reaction mechanisms of organic compounds, 20: 348
use in quantitative analysis by extraction, calibration curves, optimum conditions, and sensitivity of, 20: 245
TRACER TECHNIQUES (HYDROLOGY)
development, 20: 548
TRACER TECHNIQUES (MEDICINE)
bibliography on, 20: 164 (TID-3077(Suppl.1))
development of renography using iodine-131-Hippuran, 20: 163(R) (STI/DOC/10/42, pp 71-127)
for iron metabolic studies, 20: 169
hemodynamic studies on patients with Chagas disease, 20: 163(R) (STI/DOC/10/42, pp 71-127)
method for diagnosis of liver diseases, 20: 174
preparation of labeled compounds for use in, 20: 200
study of high-altitude-induced polycythemia, 20: 163(R) (STI/DOC/10/42, pp 71-127)
use in diagnosis of brain tumors, 20: 179
use in diagnosis of, 20: 207
TRACER TECHNIQUES (METEOROLOGY)
diffusion experiments on French nuclear sites, 20: 540 (CONF-650407, pp 394-404)
TRACER TECHNIQUES (OCEANOGRAPHY)
sand erosion and displacement by surf, 20: 510 (EUR-2167.d)
TRADESCANTIA
radioinduced chromosome aberrations in seeds of, 20: 97
TRANSDUCERS
development of pressure-sensitive, 20: 1534(R) (LA-3370)
TRANSISTORS
radioinduced surface effects in, 20: 695
uses of field-effects, in null detector for impedance bridges, 20: 637
TRANSITION METALS
critical temperature of superconducting alloys of niobium and, 20: 1129
phase diagrams, prediction of multicomponent, 20: 882
TRIDODECYLAMINE
solvent properties for mineral acids, 20: 223 (CEA-R-2760)
TRIETHYLAMINE
effects on radioinduced polymerization of methyl acrylate at 25 to −116°C, 20: 405
TRIOCTYLAMINE
use in extraction chromatography of metal ions, 20: 433 (INP-412/C)
TRIOXANES
radioinduced polymerization of compressed particulate, 20: 415(P)
TRITHIANE
radiation effects on, orientation of twinned polythiomethylene crystals obtained by, 20: 353
TRITIUM
chemistry in thermonuclear reactors, 20: 1274(R) (ORNL-3836, pp 111-16)
concentration by diffusion through palladium, 20: 272
content in surface and ground waters of karst region, Turkey, 20: 538
content of, in rain water of hurricanes, 20: 519
determination in biological materials by oxidation and liquid scintillation counting, 20: 253
effects of thymidine labeled with, carcinogenic, 20: 66 (TID-22292)
exchange between water and methane, 20: 469(R) (ORNL-TM-1275)
exchange with hydrogen in alkylbenzenes, 20: 347(R) (TID-22251)
incorporation in nucleic acids, lysozyme, and ribonuclease, 20: 2 (EUR-2419.f)
incorporation in *O,O*-dimethyl-*S*-(methylcarbamoylmethyl)phosphorodithioate, 20: 423
incorporation in peptides and proteins, 20: 344 (EUR-1845.f)
reactions of recoil, with organic compounds, 20: 359
sound velocity in liquid, quantum cell model for, 20: 1089
structure of, electron scattering studies of, 20: 1234
TROPOSPHERE
fallout transport in, meteorological factors in, 20: 523
TUBERCULOSIS
radiographic diagnosis in man of, 20: 202
TUMORS
breast, prognostic indications for, 20: 60(R) (NYO-901-37, pp 33-68)
effects of therapy, prediction using biological model, 20: 57(R) (NYO-901-37, pp 7-13)
etiology of, 20: 60(R) (NYO-901-37, pp 33-68)
growth rate predictions, biological model for, 20: 57(R) (NYO-901-37, pp 7-13)
host responses to, 20: 60(R) (NYO-901-37, pp 33-68)
induced in man by radiosterilized sutures, 20: 712
induction by benzanthracene, in female rats, 20: 60(R) (NYO-901-37, pp 33-68)
induction in human liver by thorium dioxide, 20: 123
interstitial cell, induction in rats by cadmium injection and vascular ligation, 20: 10 (TID-21261)
pathology of, 20: 60(R) (NYO-901-37, pp 33-68)
radiation effects on collagen synthesis by subcutaneous granulomas in rats, 20: 52
radioinduced in mice, by radioactive thymidine, 20: 66 (TID-22292)
radioinduced intestinal, after radiotherapy, 20: 192
radioinduced skin, etiology of, 20: 183
radiosensitivity of human, in hamster cheek pouch culture, 20: 60(R) (NYO-901-37, pp 33-68)
radiosensitivity of glioblastoma cells, in culture, 20: 101
radiosensitivity of, effects of oxygen pressure on, 20: 170
radiotherapy of, 20: 60(R) (NYO-901-37, pp 33-68)
radiotherapy of breast, pathological effects on heart, 20: 213
radiotherapy of eye, using cobalt-60 applicators, 20: 168
radiotherapy of eye, hazards from, 20: 172
radiotherapy of malignant thyroid, using iodine-131, 20: 196
radiotherapy of mouth, evaluation, 20: 175
radiotherapy of retinoblastoma, late pathological effects from, 20: 168
radiotherapy of skin, 20: 171
radiotherapy of skin, use of plastic material with imbedded cobalt-60 as radioapplicator, 20: 177
radiotherapy of thyroid-gland, etiology and pathology of, 20: 203
radiotherapy of thyroid, using iodine-131, 20: 203
radiotherapy of uterine, effects of vitamin therapy on results of, 20: 191
radiotherapy of, dose measurements for, 20: 204
radiotherapy of, medical care of patients during, 20: 184
radiotherapy of, synergistic effects of chemotherapy, 20: 194
radiotherapy of, use of high-pressure oxygen in, 20: 170
surgical treatment of, 20: 60(R) (NYO-901-37, pp 33-68)
TUNGSTEN
annealing of rolled single crystal of, 20: 819(R) (GA-6413)
bibliography on, 20: 753 (SB-415(Suppl. 1))
degasification by electron bombardment, 20: 915 (ORNL-TM-1166)
diffusion of copper on, field-emission microscopy of adsorption and surface, 20: 849
dislocation motion at low temperatures, mechanism, 20: 819(R) (GA-6413)
effects on isotopic exchange between cyclobutane and deuterium, 20: 304
etching dislocations on oriented single-crystal faces of, 20: 866
fabrication of powders of, into thin-walled cylinders, method for, 20: 781 (AI-65-12)
mechanical properties of composites of, fibers in copper matrix, 20: 884
properties and structure of new granular product of, 20: 879
rare earth ionization and oxidation on, in oxygen atmosphere, 20: 757
rolling of single crystal of, into sheet, 20: 819(R) (GA-6413)
solubility in nickel, effects of iron on, 20: 865
solubility in plutonium at 700 to 950°C, 20: 1534(R) (LA-3370)
superconductivity of thin films of, 20: 813 (BNL-9479)
vapor pressure, 20: 331
vaporization of, under vacuum and forced convection conditions, (T), 20: 831 (UCRL-14274)
TUNGSTEN ALLOYS
bibliography on, 20: 753 (SB-415(Suppl. 1))
Au–W, electron reactions with, bremsstrahlung spectral distributions from, 20: 651 (EGG-1183-2055)
Fe–Ni–W, diffusion in sintered, 20: 865
Hf–Ta–W, cavitation damage of T-111 in bismuth–lead alloy at 500 and

1500°F, 20: 771 (NP-15558)
Hf–Ta–W, thermal properties to melting point, 20: 878
Nb–Ta–W–Zr, thermal properties to melting point, 20: 878
Nb–W–Zr, thermal properties to melting point, 20: 878
Ta–W, carburization for fuel capsules, methods for, 20: 1534(R) (LA-3370)
Ta–W, testing for molten plutonium fuel container, 20: 1534(R) (LA-3370)
Ta–W, thermal properties to melting point, 20: 878
Ta–W–Y, carburization for fuel capsules, methods for, 20: 1534(R) (LA-3370)
Tc–W, structure of arc-melted, 20: 814(R) (BNWL-142)
TUNGSTEN CARBIDES
Co–WC, aging mechanism of sintered and annealed, 20: 859
Co–WC, extrusion of, development of techniques for, 20: 796
Co–WC, torsion fatigue strength at −200 to 600°C, 20: 875
TUNGSTEN CARBONYLS
complexes with cyclic phosphite esters, 20: 1561 (IS-T-31)
TUNGSTEN COMPOUNDS
bibliography on, 20: 753 (SB-415(Suppl. 1))
TUNGSTEN ISOTOPES W-182
energy levels of, lifetime of, (E), 20: 1175
TUNGSTEN ISOTOPES W-187
decay, (E), 20: 1179
TUNGSTEN OXIDES
Al_2O_3–WO_3, phase studies on, 20: 848
B_2O_3–WO_3, phase studies on, 20: 847
W–WO_2, phase studies and thermodynamic properties of, 20: 881
TUNGSTEN SYSTEMS
C–Hf–Ta–W, cavitation damage of T-222 in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
C–Hf–Ta–W, erosion by sodium at 400, 1000, and 1500°F of T-222, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–Ta–W–Zr, erosion by sodium at 400, 1000, and 1500°F of Cb-132M, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–W–Zr, thermal properties to melting point, 20: 878
C–Mo–W–Zr, thermal properties to melting point, 20: 878
C–Nb–W–Y–Zr, corrosion by potassium at 2000°F of AS-55, 20: 768(R) (NASA-CR-54226)
C–Nb–W–Zr, corrosion by potassium at 2000°F of D-43, 20: 768(R) (NASA-CR-54226)
W–O, phase studies and thermodynamic properties of, 20: 881
W–UO_2, diffusion and reactions in, 20: 339
W–UO_2, thermal conductivity to 2500°C, 20: 820 (GE-TM-64-10-4)
W–WO_2, phase studies and thermodynamic properties of, 20: 881
TURKEY
deuterium, oxygen-18, and tritium contents of surface and ground waters of karst region, 20: 538

U

ULTRASONICS
use for CP-5 reactor fuel quality evaluation, 20: 1533 (CONF-650532-2)
use in decontamination of copper and brass, 20: 430 (CEA-R-2823)
wave propagation in niobium–zirconium alloys, magnetic field effects on, 20: 863
ULTRAVIOLET RADIATION
bacteriophage induction in *Escherichia coli* by, 20: 127
effects on disruption of specific cystines in ribonuclease, 20: 51
effects on green colony formation in *Euglena gracilis*, 20: 129
effects on homocysteinethiolactone, ESR spectra of, 20: 386
effects on mutation induction in *Streptomyces citreus*, 20: 124
effects on skin, effects of drugs on, 20: 73
effects on skin, toxic, 20: 74
effects on soluble collagen, 20: 48
effects on sulfhydryl content in rat skin, uv, 20: 93
effects on virus, biological, 20: 126
effects with and without electrons on aluminum, glass, paint, and stainless steel, 20: 910
induced spectroscopic and chemical changes in polyvinyl chloride, 20: 384
protection against, effects of triprolidine, 20: 132
reactions with neopentane gases, products from, 20: 369
UNDECANOIC ACID
sorption by annealed and oxidized copper and nickel single crystals, 20: 1570 (TID-22150)
1-UNDECANOL
eicosafluoro-, radiolysis of, ESR spectra of gamma, 20: 372
UNDERGROUND EXPLOSIONS
energy flow from atomic, diffusion theory of seismic, 20: 547
seismic wave propagation from, 20: 542 (NP-15557)
use for producing radioactive materials, 20: 730(P)
use in excavation of Isthmian sea-level canal, 20: 471 (PNE-1999)
use in excavation of Isthmian sea-level canal, general construction plan for, 20: 472 (PNE-2005)
use in excavation of Isthmian sea-level canal, on-site survey program for, 20: 473 (PNE-2006)
use to stimulate natural gas reservoirs, Gasbuggy experiment on, 20: 470 (PNE-1000)
uses in mining, research program on chemical, 20: 469(R) (ORNL-TM-1275)
UNDERGROUND STRUCTURES
design of protective, in hard rock, 20: 496
gamma and neutron scattering in concrete, methods for calculating, 20: 1307 (RRA-M45)
gamma and neutron scattering in concrete, calculations for, (E/T), 20: 1308 (RRA-T41)
gamma and neutron scattering in concrete and iron, methods for calculating, 20: 1310 (RRA-T51)
stresses on, in hard rock, from shock waves of nuclear explosions, 20: 495
UNITED STATES
nuclear power plant economics in coordinated networks in, 20: 1488
URACIL
radioinduced free radicals in, ESR spectroscopy of, 20: 421
URACIL, 2-THIO-
effects on hyperthyroidism, therapeutic, 20: 176
URANIUM
analysis for carbon and nitrogen, effects of nitric acid etching on, 20: 230 (NLCO-965, pp 4.1-5)
analysis for traces of aluminum, iron, nickel, and silicon, using electron microprobe, 20: 225 (CONF-650810-2)
casting of, use of infrared pyrometers for pouring temperature control for, 20: 784(R) (NLCO-965, pp 3.1-5)
coating with aluminum, method for, 20: 802(P)
compression by shock waves, dynamic adiabatic curve, 20: 836(T) (UCRL-Trans-1213(L))
content in sea water from Sagami Bay, Japan, 20: 512
deformation twinning in alpha-, mechanism of, 20: 850
determination in reactor fuels, destructive, 20: 234(R) (STI/DOC/10/42, pp 57-8)
determination in solutions by amalgam polarography with electrolysis, 20: 273
diffusion in aluminum, properties of vanadium as barrier in, 20: 855
dissolution in nitric acids, 20: 276(P)
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
heat treatment process for reactor fuel tubes of, 20: 785(R) (NLCO-965, pp 5.1-10)
neutron fission of uranium-235 and -238 in, ratio of fast, (E), 20: 1147 (CRRP-1220)
particle reactions with, analysis of high-energy fission, (E), 20: 652 (INR-647/I-A,VI/PH)
photoelectric effect at 0.01 to 2.00 Mev, total cross sections for, (T), 20: 968
processing of depleted fuel elements of, method and device for electrolytic, 20: 454(P)
processing of irradiated fuels containing, 20: 455(P)
production by magnesium reduction of uranium tetrafluoride, 20: 761(P)
production by reduction of oxide, using liquid magnesium–zinc alloy, 20: 741 (ANL-7057)
production by uranium tetrafluoride reduction by magnesium, 20: 749(R) (NLCO-965, pp 1.1-5)
radioinduced swelling in, effects of pressure on reactor, 20: 745(R) (BNWL-120, pp 3.1-22)
release from irradiated uranium dioxide, 20: 894 (RT/CBI(65)27)
separation from aluminum-based fuel elements by fused-salt fluoride-volatility process, 20: 442
separation from cadmium, hafnium, terbium, and zinc by extraction chromatography, 20: 433 (INP-412/C)
separation from low-grade ores by carbonate leaching, 20: 451(P)
separation from ores, effects of preconcentration by flotation on, 20: 450
separation from plutonium by solvent extraction using secondary and quaternary ammonium nitrates, 20: 437 (RT/CHI(65)21)
separation from plutonium by selective hexafluoride reduction, 20: 445
separation from plutonium by solvent extraction using cadmium–magnesium–zinc melt, 20: 447
separation from plutonium, electrolytic method for, 20: 456(P)
separation from thorium, chromatographic, 20: 449
separation from uranium minerals and leach solutions, 20: 440
use in European power reactors, 20: 1463 (EUR-2445.f)
vapor pressure, 20: 331
URANIUM ALLOYS
Al–Co–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873

Al–Fe–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Al–Mn–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Al–U, dissolution of plates of, mercury-catalyzed nitric acid, 20: 438 (RT/CHI(65)23)
Al–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Al–U, fabrication of aluminum-clad, quality control in, 20: 795
Al–U, separation of uranium from, by fused-salt fluoride-volatility process, 20: 442
Co–Mn–U, phase diagrams, intermetallic compounds in, 20: 874
Co–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Cr–U, separation of barium-140 and lanthanum-140 from irradiated droplets of, by solvent extraction using molten magnesium, 20: 292 (UCRL-16173)
Fe–U, analysis for U_6Fe, method for, 20: 750(R) (NLCO-965, pp 6.1-8)
Fe–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Mn–U, electric and thermal properties of Laves phases of intermetallic compounds in, 20: 873
Pu–U, separation of plutonium from, by Lamex process, 20: 443
Sn–U, temperature dependence of tin Knight shift and magnetic susceptibility in, 20: 861
Th–U, extrusion of Zircaloy-2-clad fuel tubes of, 20: 782 (DP-943)
Th–U, radioinduced swelling of Zircaloy-2-clad fuel tubes of, reactor, 20: 782 (DP-943)

URANIUM CARBIDES
casting rods of, arc instabilities and crack formation in, 20: 791
diffusion of xenon from monocrystals of, 20: 1324(R) (EURAEC-1428)
etching and polishing pyrolytic carbon-coated, 20: 797
fabrication of small spheres of, from melts and melt suspensions, 20: 792
fabrication of spherical particles of, by powder agglomeration method, 20: 793
fission gas release from irradiated carbon-coated particles of, 20: 899
melting point of, effects of carbon content on, 20: 825 (NLCO-965, pp 2.1-3)
neutron fission of uranium-235 and -238 in, ratio of fast, (E), 20: 1147 (CRRP-1220)
neutron resonance integrals for, temperature-dependent, (T), 20: 1148 (CRRP-1222)
radiation effects on clad, 20: 907
Pu_2C_3–U_2C_3, crystal structure, 20: 1534(R) (LA-3370)

URANIUM(IV) CHLORIDE COMPLEXES
with pyridine-1-oxides, proton magnetic resonance spectra of, 20: 301

URANIUM(III) CHLORIDES
KCl–UCl_3, preparation for testing as reactor blanket, 20: 1534(R) (LA-3370)

URANIUM(IV) CHLORIDES
chlorination by chlorine in fused salt, kinetic studies, 20: 292 (UCRL-16173)

URANIUM COMPLEXES
with malic acid, polarography at 15°C, 20: 295
with phosphoörganic compounds in TTA and 2,4-pentanediones, synergism in, 20: 261

URANIUM(IV) FLUORIDES
conversion to uranía, effects of molten salts on electrochemical, 20: 432(R) (EURAEC-1402)
oxidation of, equipment and methods for production of uranium hexafluoride by, 20: 432(R) (EURAEC-1402)
reduction by magnesium for uranium metal production, 20: 749(R) (NLCO-965, pp 1.1-5)
reduction by magnesium, 20: 761(P)
reduction to metal by liquid magnesium–zinc alloy, 20: 741 (ANL-7057)
volatilization of, effects of alumina on, 20: 432(R) (EURAEC-1402)

URANIUM(VI) FLUORIDES
production from uranium tetrafluoride, equipment and methods for, 20: 432(R) (EURAEC-1402)
reactions with freons, hydrogen, and sulfur dioxide, 20: 445
shipping containers for, destructive tests of ten-ton, 20: 593 (KY-500)

URANIUM IONS
disproportionation in organic acid solutions, kinetics of pentavalent, 20: 328
electron exchange between tetravalent and hexavalent, tracer studies of effects of sulfate ions on, 20: 296
oxidation by thallium(III) in aqueous perchloric acid, effects of tartaric acid on kinetics of, 20: 319
oxidation in organic and perchloric acids, effects of disproportionation reactions on pentavalent, 20: 326
reduction in organic and perchloric acids, effects of disproportionation reactions on hexavalent, 20: 326

URANIUM ISOTOPES U-233
determination of, fission-counting technique for, 20: 228 (LA-DC-7439)
neutron capture and fission constants for, survey on, 20: 1164

URANIUM ISOTOPES U-234
content in sea water from Sagami Bay, Japan, 20: 512

URANIUM ISOTOPES U-235
burnup in MTR-type fuel elements, gamma spectroscopy for analysis of, 20: 1440
determination in irradiated fuel system by neutron activation methods, 20: 241
determination of, fission-counting technique for, 20: 228 (LA-DC-7439)
distribution in solid homogeneous critical assembly fuel, method for measurement of, 20: 227 (KAPL-M-6448)
neutron capture and fission constants for, survey on, 20: 1164
neutron fission of, ratio to uranium-238, (E), 20: 1147 (CRRP-1220)
performance ad CP-5 reactor fuel, methods for determining, (E), 20: 1533 (CONF-650532-2)
use in European power reactors, 20: 1463 (EUR-2445.f)

URANIUM ISOTOPES U-238
content in sea water from Sagami Bay, Japan, 20: 512
neutron fission of, ratio to uranium-235, (E), 20: 1147 (CRRP-1220)
neutron reactions (n,γ) at 30 kev, gamma spectra from, (E), 20: 1168
neutron resonance calculation of, comparison of methods for, 20: 1158 (ORNL-TM-1296)
proton fission reactions at 7 to 12 Mev, charge and mass distributions from, (E/T), 20: 1247

URANIUM ISOTOPES U-239
energy levels, (E), 20: 1168

URANIUM LEACH SOLUTIONS
efficiency of alkali metal carbonate, for low-grade ores, 20: 451(P)
separation of uranium from, evaluation of methods for, 20: 440

URANIUM LEACH SOLUTIONS (CARBONATE)
separation of uranium from, by solvent extraction, 20: 441

URANIUM MINERALS
leaching of, natural, 20: 440

URANIUM NITRATES
spectra of, in TBP solutions, 20: 321

URANIUM NITRIDES
fabrication and hot pressing of, review on, 20: 799
production by carbothermic reduction of uranium dioxide in nitrogen, calculation of equilibrium yields in, 20: 288 (ORNL-TM-1264)
radiation effects on stainless steel-clad mono-, 20: 888 (BMI-1731)
sintering of, method for, 20: 806(P)
TiN–UN, fabrication of fuels of, 20: 803(P)
UN–UO_2, fabrication of fuels of, 20: 807(P)

URANIUM ORES
leaching uranium from, effects of preconcentration by flotation on, 20: 450
leaching with alkaline carbonate solution, 20: 451(P)
processing Japanese, by leaching and solvent extraction, 20: 441

URANIUM OXIDES
fabrication of spherical particles of, by powder agglomeration method, 20: 793
radiation effects, 20: 1352(T,R) (JPRS-31526)
sorptive properties of particles of, for radioiodine, 20: 216 (CONF-650407, pp 242-75)

URANIUM(IV) OXIDES
criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
crystal growth of, by floating-zone method, 20: 758
crystal growth studies of, (E), 20: 287 (ORNL-P-1611)
diffusion of fission products from, calculations of, 20: 854
diffusion of xenon in monocrystals of, literature review, 20: 1324(R) (EURAEC-1428)
fluorination using chlorine trifluoride, 20: 432(R) (EURAEC-1402)
neutron fission of uranium-235 and -238 in, ratio of fast, (E), 20: 1147 (CRRP-1220)
neutron resonance integrals for, temperature-dependent, (T), 20: 1148 (CRRP-1222)
performance of Zircaloy-2-clad, fuel rods with central melting, irradiation, 20: 893 (GEAP-5100A)
radiation and thermal effects on stainless steel-clad, 20: 1542
radiation effects on clad, 20: 907
radioinduced failure of Zircaloy-clad, 20: 1466(R) (HPR-63)
radioinduced reactions with stainless steel, 20: 1465(R) (GEAP-4894)
reduction by carbon in nitrogen, calculation of equilibrium yields of uranium nitrides in, 20: 288 (ORNL-TM-1264)
reduction to metal by liquid magnesium–zinc alloy, 20: 741 (ANL-7057)
release of fission products and uranium from irradiated, 20: 894 (RT/CBI(65)27)
spectra of, effects of particle size and preparation method on reflection, 20: 318
testing of clad, performance in SPERT-I, 20: 1416
thermal conductivity at 1000 to 2500°C, 20: 820 (GE-TM-64-10-4)

Mo–UO_2, diffusion and reactions in, 20: 339
PuO_2–stainless steel–UO_2, analysis of cermets of, for plutonium, 20: 222 (AERE-R-4975)
PuO_2–UO_2, performance as fuels in water moderated reactors, (T), 20: 1436 (GEAP-4907)
PuO_2–UO_2, preparation of coated spherical particles of, 20: 747 (EURAEC-1391)
PuO_2–UO_2, reactivity calculations for use in EBWR, 20: 1457 (BNWL-126)
PuO_2–UO_2–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
Sc_2O_3–UO_2, phase diagram, 20: 839
UN–UO_2, fabrication of fuels of, 20: 807(P)
UO_2–H_2O, criticality data for homogeneous, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
UO_2–Y_2O_3, thermal conductivity up to 2000°C, 20: 820 (GE-TM-64-10-4)
W–UO_2, diffusion and reactions in, 20: 339
W–UO_2, thermal conductivity to 2500°C, 20: 820 (GE-TM-64-10-4)

URANIUM(IV-VI) OXIDES
reduction to metal by liquid magnesium–zinc alloy, 20: 741 (ANL-7057)

URANIUM(VI) OXIDES
thermal decomposition of monohydrates of, at 220 to 800°C, infrared spectra of products of, 20: 870

URANIUM PERCHLORATES
spectra of, in TBP solutions, 20: 321

URANIUM RESERVES
estimates of free-world, 20: 552 (NP-15534)

URANIUM SELENIDES
thermal capacity and thermodynamic properties of, at 5 to 350°K, 20: 323

URANIUM SULFIDES
radiation and thermal effects on tantalum-clad, 20: 1542

URANIUM SYSTEMS
Al–C–Fe–Si–U, radioinduced swelling in, effects of pressure on reactor, 20: 745(R) (BNWL-120, pp 3.1-22)
CaF_2–U, diffusion of argon and xenon from monocrystals of, 20: 1324(R) (EURAEC-1428)
graphite–U, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
nitric acid–U–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
U–D_2O, neutron fission of uranium-235 and -238 in, ratio of fast, (E), 20: 1147 (CRRP-1220)
U–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))

URANYL IONS
determination by amperometric titration, 20: 255
exchange on phosphonate resin Bio-Rex 63, kinetics of, 20: 263

URANYL NITRATES
separation from thorium by ion exchange followed by solvent extraction using trioctyl phosphine oxide, 20: 242

URIDINE, 5-BROMO-2'-DEOXY-
effects on x-ray-induced breakage of chromosomes, 20: 46 (PRNC-40)

URINE
analysis for cobalt-57-vitamin B_{12}, radiometric, 20: 28
calcium content in human, following intravenous injection of strontium-85, 20: 32
cesium-137 content in guinea pig, following injection by different routes, 20: 33
excretion of thorium-228 decay products in beagle, 20: 42
rare earths in, residue studies of, 20: 25(R) (TID-22294)
scandium-46 in human, effects of DTPA and EDTA on, 20: 31
strontium-85 content in human, following intravenous injection, 20: 32

UTAH
radioactivity levels in fossil fuels from, 20: 152(R) (NYO-3086-1 Pt.VIII)

UTERUS
carcinomas of cervix, metastases of, 20: 60(R) (NYO-901-37, pp 33-68)
radiotherapy of carcinomas of, late pathological effects on intestine, 20: 186
radiotherapy of cancers of, effects of vitamin therapy on results of, 20: 191
radiotherapy of carcinomas of, effects on rectum, 20: 193
radiotherapy of cancers of, late pathological effects on intestine, 20: 210
radiotherapy of carcinomas of, effects on lymph node metastases, 20: 212
radiotherapy of cervical carcinomas in, during pregnancy, 20: 201

V

VACUUM
effects of ultrahigh, on fatigue of refractory alloys at high temperatures, 20: 824(R) (NASA-CR-54458)

VACUUM PUMPS
design and efficiency of diffusion-sorption, 20: 507

VACUUM SEALS
design of quick, 20: 505 (ORNL-P-1517)

VACUUM SYSTEMS
design and development for encapsulated electromagnets, 20: 504(R) (ORNL-3836, pp 120-9)
development for isotope target preparation, 20: 696(R) (ORNL-3829)
electron transmission windows for, carbon-coated, 20: 509(P)
residual gases in oil-diffusion-pumped ultrahigh, effects of trapping conditions on, 20: 506

VACUUM TECHNIQUES
book: *Practical Vacuum Techniques*, 20: 508

VACUUM VALVES
design of quick, 20: 505 (ORNL-P-1517)

VAK REACTOR
electric system of, design review, 20: 1507

VANADIUM
determination using 5,7-diiodo-8-hydroxyquinoline (diiodoxine), heterometric, 20: 257
diffusion barrier between aluminum and uranium, 20: 855
melting of, composition of gases evolved during electron beam, 20: 872
vapor pressure, 20: 331

VANADIUM ALLOYS
Ga–V, crystal structure of intermetallic compounds in, 20: 871
Mo–Nb–V–Zr, thermal properties to melting point, 20: 878
Nb–Ta–V, thermal properties to melting point, 20: 878

VANADIUM CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)

VANADIUM COMPOUNDS
analytical uses for determination of cerium in magnesium alloys by potentiometric titration, 20: 274

VANADIUM ISOTOPES V-51
deuteron reactions (d,α) with, distorted-wave model in, (E/T), 20: 1238
deuteron reactions (d,p) at 10.1 Mev, (E/T), 20: 1167
proton reactions (p,n) at 370 Mev, nuclear-structure effects in, (E/T), 20: 1213

VANADIUM ISOTOPES V-52
energy levels, (E), 20: 1167

VAPOR PRESSURE
of metals and some refractory metalloids of groups IV, V, VI, VII, and VIII, 20: 331

VAPORIZATION
of nuclear materials at high temperatures, thermodynamics of, 20: 283 (COO-1140-129)

VESSELS
gamma transport, 20: 160

VINYL ALCOHOL POLYMERS
radioinduced graft polymerization of acrylonitrile on, 20: 401

VIRUSES
antigen isolation from adeno-, centrifugation for, 20: 7(R) (ORNL-3883)
effects of water-d_2 on plaque size of western equine encephalitis, 20: 39
growth of x-irradiated Rous sarcoma, on chick embryo chorioallantoic membrane, 20: 103
isolation of, from dogs, use of tissue cultures of canine origin for, 20: 4 (LF-26)
radioinduced inactivation of Southern bean mosaic, ultraviolet, 20: 126
respiratory syncytial, antigen isolation by zonal centrifugation from, 20: 7(R) (ORNL-3883)

VITAMIN B_{12}
metabolism, tracer study using cobalt-57, 20: 28

VITAMINS
effects on radiotherapy of cervical cancers, 20: 191

W

WASTE DISPOSAL
at Lawrence Radiation Laboratory, 20: 1552 (UCRL-14320)
centralized removal of wastes from sites of accumulation for, 20: 1553
methods at Saxton Reactor, 20: 1508
of low- and medium-level liquid wastes at Savannah River Plant, 20: 1548 (DPSPU-65-30-30)

WASTE PROCESSING
at Lawrence Radiation Laboratory, 20: 1552 (UCRL-14320)
ceramics preparation from irradiated fuel swarf, 20: 1554
incorporation of wastes in vitreous materials, 20: 1556
instrumentation for pilot plant for low-level, engineering drawings for, 20: 1557
methods development, 20: 1352(T,R) (JPRS-31526)
of low- and medium-level liquid wastes at Savannah River Plant, 20: 1548 (DPSPU-65-30-30)
plant-scale recovery of promethium-147 at Hanford, 20: 1551 (RL-SA-53)

WASTE SOLUTIONS

decontamination of low-level, by scavenging-precipitation and foam separation, 20: 1549 (ORNL-3811)
separation of americium from plutonium aqueous, by solvent extraction using dibutyl butyl phosphonate, 20: 436 (RL-SEP-518)
separation of plutonium from analytical laboratory, 20: 435 (RFP-551)
separation of promethium-147 from, plant-scale demonstration of processes for, 20: 1551 (RL-SA-53)

WATER
analysis for boron and strontium, spectrochemical, 20: 256
analysis for heavy water by nuclear magnetic resonance spectra, 20: 239
content in snow deposits, gamma spectroscopic determination of, 20: 549
content in soils, determination by neutron thermalization, 20: 544
corrosive effects on high-silicon aluminum alloys, 20: 763 (BNWL-125)
corrosive effects on type 304 stainless steel, effects of surface finish on, 20: 765(R) (EURAEC-1387)
corrosive effects on Creusot 1.2 MD 07 boilerplate steel, effects of flow rate on, 20: 765(R) (EURAEC-1387)
corrosive effects on type 410 stainless steel, effects of surface finish on, 20: 766(R) (EURAEC-1445)
corrosive effects on type 304 stainless steel, effects of flow rate on, 20: 766(R) (EURAEC-1445)
effects on corrosion of iron by terphenyl, 20: 777
effects on crystal structure of oxide films on zirconium, 20: 778
effects on desorption of radioiodine from clays and sediments, 20: 600 (ORNL-P-1581)
electron scattering by, cross sections for, (T), 20: 973
exchange of deuterium between hydrogen and, apparatus for, 20: 264
fallout contamination at Argonne, New York, and New Zealand, 20: 521(R) (HASL-164)
gamma scattering at 1 Mev, total field for multiple, (T), 20: 1321
neutron fluxes and spectra in reactor shielding of, fast, (E/T), 20: 1318
neutron slowing down in, without polarization loss, (T), 20: 1134 (ORNL-P-1604)
oxidation of Zircaloy-2 at 900 to 1200°C, kinetics of, 20: 762(R) (BNWL-120, pp 5.1-18)
proton transfer by, Grotthuss mechanism in, 20: 340
radiation effects on, behavior of ion spurs and tracks in alpha and gamma, (T), 20: 370
radiation effects on, mechanism and rate of, 20: 390
reactions with dicarboxylic acids, kinetics of proton abstraction in, 20: 350
tritium exchange with alkylbenzenes, 20: 347(R) (TID-22251)
tritium exchange with methane, 20: 469(R) (ORNL-TM-1275)
acetone–H_2O, deuterium isotope rate effects of solvolysis of substituted bromo- and chlorohydrocarbons in, 20: 336
acetone–H_2O, equivalent conductivity of hydrochloric acid in, 20: 336
boric acid–H_2O, corrosive effects on aluminum, 20: 1467(R) (IDO-28649)
ethanol–H_2O, deuterium isotope rate effects of solvolysis of substituted bromo- and chlorohydrocarbons in, 20: 336
ethanol–H_2O, equivalent conductivity of hydrochloric acid in, 20: 336
Fe–isobutylol–O–H_2SO_4–H_2O, radioinduced oxidation and reduction reactions of iron ions in, 20: 388
nitric acid–U–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
nitric acid–Pu–H_2O, criticality data for, 20: 1410 (AHSB(S)HAND-BOOK-1(1st.Rev.))
plutonium oxalate–H_2O, criticality data, 20: 1410 (AHSB(S)HAND-BOOK-1(1st.Rev.))
Pu–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
PuO_2–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1 (1st.Rev.))
PuO_2–UO_2–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
steam–water, critical flow, (T), 20: 488
U–H_2O, criticality data for, 20: 1410 (AHSB(S)HANDBOOK-1(1st.Rev.))
UO_2–H_2O, criticality data for homogeneous, 20: 1410 (AHSB(S)HAND-BOOK-1(1st.Rev.))

WATER-d_2
analysis for deuterium, gas-chromatographic, 20: 265
determination in light water by nuclear magnetic resonance spectra, 20: 239
effects on plaque size of western equine encephalitis virus, 20: 39
measurement and status in HBWR, 20: 1466(R) (HPR-63)
reactions with diborane, isotopic effects in, 20: 306
reactions with dicarboxylic acids, kinetics of proton abstraction in, 20: 350
Fe–D_2O, neutron spectra in laminated, fast, (E/T), 20: 1304 (AE-196)
U–D_2O, neutron fission of uranium-235 and -238 in, ratio of fast, (E), 20: 1147 (CRRP-1220)

WATER-t_2
hazards of, produced in heavy water reactors, 20: 927

WATER COOLED REACTORS
design, 20: 1425(P)
design development for CIRENE, 20: 1489
design of, fast supercritical, 20: 1515
development and principles of graphite-moderated pressure-tube, 20: 1493

WATER MODERATED REACTORS
design of, with hold-down arrangement for fuel elements, 20: 1431(P)
plutonium recycle economics for, (T), 20: 1436 (GEAP-4907)

WATER PURIFICATION EQUIPMENT
use in treatment of Clinch River water at Oak Ridge Gaseous Diffusion Plant, 20: 592 (K-C-785)

WATER SUPPLIES
decontamination using sanitary treatment process, 20: 592 (K-C-785)

WATER VAPOR
effects on iodine-131 sorption by activated charcoal, 20: 278 (CONF-650407, pp 814-29)
effects on methyl iodide retention in charcoals, 20: 279 (CONF-650407, pp 852-68)
effects on removal of iodine vapor and methyl iodide from air by activated charcoals, 20: 280 (CONF-650407, pp 869-84)

WATER WAVES
detection of tsunami, operational and support requirements plan for, 20: 543(R) (NVO-98-9)

WEAR
measurement of, for refractories in blast furnaces, using radiometric methods, 20: 715

WELDING
of stainless steel-clad carbon steel, for fabrication of piping, 20: 788 (SWRI-1228-73)
plasma jet uses in, 20: 1277 (TID-22136)

WELDS
crack effects on fatigue strength of carbon steel pipe, 20: 759

WHEAT
gamma attenuation coefficients for, (E/T), 20: 716
radiation effects on nutritive value in animals, gamma, 20: 50

WIND
direction measurement for diffusion parameter determinations, method for, 20: 514 (CONF-650407, pp 429-38)
measurement of, constant-temperature-difference meter for, 20: 516 (TID-22278)

WINDSCALE ADVANCED GAS COOLED REACTOR
core performance, (T), 20: 1498
electric system of, design review, 20: 1507
moderator for, properties of graphite, 20: 1497

WOOD
gamma attenuation by pine, 20: 1313
processing of, uses of radioisotopes in, 20: 710
processing of, uses of radioisotopes in, 20: 711
radioisotope uses in industry of, 20: 706

WYOMING
radioactivity levels in fossil fuels from, 20: 152(R) (NYO-3086-1 Pt.VIII)

X

X RADIATION
absorption by atoms, energy levels from, (T), 20: 960 (AROD-2810.18)
absorption by elements of atomic numbers 1 to 30, 20: 923
detection and measurement of, energy dependence of alanine dosimeter for, 20: 394
dosimetry for bone marrow during chest radiography, 20: 180
dosimetry in dog tissues, method for, 20: 604
effects in barley seed, genetic, 20: 97
effects in cats, biological, 20: 43
effects in man, leukemogenic, 20: 94
effects in rabbits, biological, 20: 43
effects in rats, biological, 20: 43
effects in tritium plant cells, genetic, 20: 71
effects on activity of carboxypeptidase A, 20: 46 (PRNC-40)
effects on atherosclerosis development and lipid metabolism in pigeons, 20: 110
effects on beagle, thickness effects of central beam dose received on, 20: 113
effects on carrot tissues and tomato stems, photoreactivation of, 20: 120
effects on cholic acid excretion by liver in rats, tracer study, 20: 78
effects on chromosomes of leukocytes in tissue culture, 20: 88
effects on cornea of salamanders, pathological, 20: 82
effects on deuterated and normal methane in presence of argon, krypton, and xenon, 20: 379
effects on developing fetuses and ovaries, 20: 214
effects on DNA in bacteria, 20: 45(R) (EUR-2471.1)
effects on Ehrlich ascites cells in mice, 20: 118

effects on enzymes in beef heart muscle, 20: 63(R) (STI/DOC/10/42, pp 45-55)
effects on ESR in ammonium fluophosphate and magnesium hypophosphite, 20: 414
effects on fatty acid synthesis in liver, 20: 63(R) (STI/DOC/10/42, pp 45-55)
effects on free radical yield in DNA, effects of DNA molecular weight on, 20: 420
effects on gamete mutation frequency, maximum permissible dose from, 20: 107
effects on growth of *Vicia faba* roots, of continuous low dose-rate exposure, 20: 87
effects on growth of jaws in kittens, 20: 91
effects on growth of transplanted sarcomas in mice, protective effects of sodium cysteinethiosulfonate, 20: 131
effects on health and fertility of dentists, occupational exposure to, 20: 59(R) (NYO-901-37, pp 31-2)
effects on heart function, 20: 213
effects on hemoglobin synthesis in chickens, 20: 76
effects on homocysteinethiolactone, ESR spectra of, 20: 386
effects on immune reactions to parental spleen cell grafts in rats, 20: 86
effects on immune reactions to transplanted kidneys, 20: 125
effects on laryngeal mucosa, pathological, 20: 166(T) (N64-20943, pp 1–8)
effects on lead silicate glass, electric polarization from, 20: 410
effects on lipid content of rabbit blood, 20: 77
effects on methane and propane, effects of temperature on hydrogen yields in, 20: 381
effects on mice, pathological, 20: 60(R) (NYO-901-37, pp 33-68)
effects on mice, protective effects of bone marrow grafts against lethal, 20: 138
effects on mold cells and pectic enzymes, 20: 63(R) (STI/DOC/10/42, pp 45-55)
effects on monkeys, protective effects of cysteine–AET against, 20: 140
effects on mouse chromosomes, aberrant, 20: 65(R) (TID-22174)
effects on mutations in bacteriophage, 20: 80
effects on nervous system development in rat embryos, 20: 60(R) (NYO-901-37, pp 33-68)
effects on nuclei acid and phosphate metabolism in carrot tissues and tomato stems, effects of dose-rate on, 20: 120
effects on nucleic acid metabolism in rat lens, tracer study, 20: 89
effects on oral cancers, therapeutic, 20: 175
effects on oxidation of sulfuric acid by oxygen, dose rate effects on, 20: 412
effects on pea seeds, genetic, 20: 81
effects on phagocytic activity of, rat reticuloendothelial cells in tissue culture, 20: 85
effects on phosphors, dose dependence of, 20: 669
effects on polymerization of methyl methacrylate with isobutylene and ethylene–propylene rubbers, 20: 367
effects on polymerization of diphenylvinylphosphine oxide in presence of oxide powders, 20: 408
effects on potassium bromide crystals at room temperature, F centers produced in, 20: 46 (PRNC-40)
effects on protein solutions in presence of inorganic ions, 20: 49
effects on rat embryos, pathological, 20: 60(R) (NYO-901-37, pp 33-68)
effects on retina in newborn mice, 20: 117
effects on *Snagamus trachea*, 19: 70
effects on sodium thiosulfate single crystals, ESR spectra of free radicals in, 20: 374
effects on spermatogenesis in mice, effects on fertility of, 20: 65(R) (TID-22174)
effects on thiol content in rat liver and spleen, whole-body, 20: 108
effects on ultrastructure of gastric fundus glands in mice, whole-body, 20: 111
effects on zeolites in presence of oxygen, ESR spectra of, 20: 375
effects on 5-bromodeoxyuridine-labeled chromosomes, 20: 46 (PRNC-40)
emission in electron reactions with single crystals of copper, orientation effects on, (E), 20: 1331
emission of, use for film thickness measurements, 20: 493
photographic film detector with multi-element filters, design of energy-independent, 20: 658
use for therapy of skin tumors, 20: 171
use for therapy of cancers of uterus, effects of vitamin therapy on, 20: 191

X-RAY-DIFFRACTION ANALYSIS
technique development for biological studies, 20: 232(R) (NYO-901-37, pp 80-4)

X-RAY SHIELDING
materials for, 20: 1314

X-RAY SOURCES
development of high-intensity field-emission, 20: 46 (PRNC-40)

X-RAY SPECTROMETERS
design of time-constant control system for, 20: 640(P)

XENON
diffusion from calcium fluoride–uranium monocrystals, 20: 1324(R) (EURAEC-1428)
diffusion from uranium carbide monocrystals, 20: 1324(R) (EURAEC-1248)
diffusion in uranium dioxide monocrystals, literature review, 20: 1324(R) (EURAEC-1428)
effects on radiolysis of deuterated and normal methane, 20: 379
hydrogen halides infrared spectra in liquid, absolute intensities and band structures of, 20: 311
microwave penetration through plasma of, polarization modifications in, (E), 20: 1292
proton reactions at 1 to 23 kev, metastable 2S hydrogen atom production in, (E), 20: 982
sorption by glass and molybdenum film, physical, 20: 916(R) (SRIA-425-6)

XENON ISOTOPES Xe-126
energy level structure, (E), 20: 1173

XENON ISOTOPES Xe-129
energy levels from cesium-129 decay, (E), 20: 1200

XYLENE
effects on radiolysis of monoimine of phenanthrene-9,10-quinone, 20: 397

Y

YANKEE POWER REACTOR
accident analysis using probabilistic methodology, 20: 1461 (CONF-650407, pp 1035-56)

YEASTS
radiation effects on growth of, regeneration ability in, 20: 79

YTTERBIUM
determination in lithium chloride and lithium iodide, polarographic, 20: 249
determination of, in rare-earth mixtures, photometric, 20: 252

YTTERBIUM ISOTOPES Yb-170
energy levels of, lifetime of, (E), 20: 1175

YTTERBIUM NIOBATES
preparation and structure of perovskite type, 20: 844

YTTERBIUM OXIDES
$BaO–Yb_2O_3$, phase studies, 20: 302
$SrO–Yb_2O_3$, phase studies, 20: 302

YTTERBIUM OXYBROMIDES
preparation and structure of, 20: 869

YTTERBIUM TANTALATES
preparation and structure of perovskite type, 20: 844

YTTRIUM
determination in steel by solution spectrographic method, 20: 266
determination of, in rare-earth mixtures, photometric, 20: 252
effects on dog and rabbit membranes of contact with, 20: 25(R) (TID-22294)
effects on rabbit skin, effects of various solvents on toxic, 20: 25(R) (TID-22294)
extrusion of, high-energy-rate, 20: 783 (IS-1227)
metabolism in feces, tissues, and urine, 20: 25(R) (TID-22294)

YTTRIUM ALLOYS
Ta–W–U, carburization for fuel capsules, methods for, 20: 1534(R) (LA-3370)

YTTRIUM ISOTOPES Y-87
photoproduction of isomeric, yield ratios for, (E/T), 20: 1246

YTTRIUM ISOTOPES Y-89
photon reactions at 300 Mev peak, isomer production in, (E/T), 20: 1246

YTTRIUM ISOTOPES Y-90
decay of, contribution to total beta activity of coastal sediments of Ligurian Sea from, 20: 526
determination by autoradiography using ring-oven method, temperature effects on fading effect in, 20: 251

YTTRIUM ISOTOPES Y-91
distribution from nuclear excavation in basalt, 20: 613

YTTRIUM NIOBATES
preparation and structure of perovskite type, 20: 844

YTTRIUM OXIDES
properties of nonstoichiometric, magnetic and paramagnetic, 20: 880
thermal conductivity at 1000 to 2200°C, 20: 820 (GE-TM-64-10-4)
$Sc_2O_3–Y_2O_3$, phase diagram, 20: 840
$ThO_2–Y_2O_3$, defect structure and electric conductivity of, 20: 843
$ThO_2–Y_2O_3$, phase relations and solid solubility in, 20: 843
$UO_2–Y_2O_3$, thermal conductivity up to 2000°C, 20: 820 (GE-TM-64-10-4)
$Y_2O_3–ZrO_2$, preparation of dense and homogeneous samples by melting techniques, 20: 798

YTTRIUM SYSTEMS
C–Nb–W–Y–Zr, corrosion by potassium at 2000°F of AS-55, 20: 768(R) (NASA-CR-54226)

YTTRIUM TANTALATES
preparation and structure of perovskite type, 20: 844
YTTRIUM TUNGSTATES
hydration, 20: 307

Z

ZINC
content in teeth after use in dental restorations, 20: 27
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
electron plasma resonances in, analysis using photon scattering, (T), 20: 1326 (ORNL-P-1600)
separation from uranium by extraction chromatography, 20: 433 (INP-412/C)
slip in, effects of aluminum on basal, 20: 1560 (CALT-473-5)
sorptive properties for fission-product iodine from various environments, 20: 574 (CONF-650407, pp 730-46)
ZINC ALLOYS
Cd–Mg–Zn, solvent properties of melts of, for plutonium and uranium, 20: 447
Mg–Zn, reactions with uranium oxide, 20: 741 (ANL-7057)
ZINC CHLORIDES
properties of solutions of, in dimethyl sulfoxide, 20: 293 (UCRL-16330)
ZINC COMPLEXES
with phosphoŏrganic compounds in TTA and 2,4-pentanediones, synergism in, 20: 261
ZINC IONS
sorption from water by peat, 20: 218(R) (STI/DOC/10/42, pp 1-22)
ZINC ISOTOPES Zn-65
ingestion by man of, in oysters, 20: 553 (BNWL-SA-293)
separation by solvent extraction using phosphoŏrganic compounds in 2,4-pentanediones and TTA, synergism in, 20: 261
ZINC OXIDES
effects on radioinduced polymerization of isobutylene with vinylidene chloride, 20: 403
effects on radioinduced polymerization of diphenylvinylphosphine oxide, 20: 408
ZIRCALOY-2
analysis for hydrogen, method for, 20: 766(R) (EURAEC-1445)
corrosion in PRTR pressure tubes, causes and minimization of, 20: 1367
corrosion in PRTR, wear and crevice, 20: 764 (BNWL-SA-313)
ductility at –33 to 300°C, 20: 746(R) (BNWL-120, pp 6.1-11)
extrusion of, clad thorium–uranium fuel tubes, 20: 782 (DP-943)
oxidation by water at 900 to 1200°C, kinetics of, 20: 762(R) (BNWL-120, pp 5.1-18)
radiation effects on stress-rupture of, fast neutron, 20: 746(R) (BNWL-120, pp 6.1-11)
radioinduced swelling of, clad thorium–uranium fuel tubes, reactor, 20: 782 (DP-943)
ZIRCONIUM
analysis for impurities, mass spectrometric, 20: 235 (Y-KG-28)
determination as pyrophosphate using phosphorus-32 and counting, 20: 258
determination in zirconium alloys, electrographic, 20: 267
effects on heterometric determination of vanadium using 5,7-diiodo-8-hydroxyquinoline, 20: 257
oxidation of, crystal structure of films formed in, 20: 778
reactions with steam in loss-of-coolant reactor accident, calculations, 20: 582 (CONF-650407, pp 938-69)
separation from hafnium by reversed-phase chromatography, 20: 240
slow-bend testing of hydrided, yield-drop in, 20: 857
vapor pressure, 20: 331
ZIRCONIUM ALLOYS
Mg–Zn, reactions with thorium dioxide, 20: 742 (ANL-7058)
Mg–Zr, phase diagram, liquidus curve of, 20: 812 (BM-RI-6673)
Mo–Nb–V–Zr, thermal properties to melting point, 20: 878
Mo–Ti–Zr, erosion by sodium at 400, 1000, and 1500°F of TZM, 20: 769(R) (NASA-CR-54459)
Mo–Ti–Zr, fatigue behavior at high temperatures in ultrahigh vacuum, 20: 824(R) (NASA-CR-54458)
Mo–Ti–Zr, fatigue in sodium at 1000 and 1500°F of TZM, high-frequency, 20: 769(R) (NASA-CR-54459)
Mo–Ti–Zr, thermal properties to melting point, 20: 878
Nb–Ta–W–Zr, thermal properties to melting point, 20: 878
Nb–Ti–Zr, thermal properties to melting point, 20: 878
Nb–W–Zr, thermal properties to melting point, 20: 878
Nb–Zr, brittleness at –23 to 265°C, 20: 746(R) (BNWL-120, pp 6.1-11)
Nb–Zr, cavitation damage in bismuth–lead alloy at 500 and 1500°F, 20: 771 (NP-15558)
Nb–Zr, corrosion by potassium at 2000°F, 20: 768(R) (NASA-CR-54226)
Nb–Zr, magnetic field effects on ultrasonic wave propagation in, 20: 863
Nb–Zr, magnetic flux annihilation and instabilities in inhomogeneous superconducting, (E), 20: 1132
Nb–Zr, performance in superconducting magnets, 20: 1120(R) (ORNL-3836, pp 90-110)
Nb–Zr, superconducting critical current density in, method for increasing, (E), 20: 1121(T) (Al-Trans-97)
Ni–Zr, analysis for zirconium, electrographic, 20: 267
ZIRCONIUM CARBIDES
fabrication of spherical particles of, by powder agglomeration method, 20: 793
ZIRCONIUM FLUORIDES
AlF_3–KF–ZrF_4, uses of fused, in fluoride volatility process for separation of uranium from spent fuel elements, 20: 442
ZIRCONIUM ISOTOPES Zr-90
proton elastic scattering by, optical model parameters for distributions and polarizations from, (E/T), 20: 1157 (ORNL-P-1616)
ZIRCONIUM ISOTOPES Zr-95
distribution from nuclear excavation in basalt, 20: 613
ZIRCONIUM ISOTOPES Zr-97
distribution from nuclear excavation in basalt, 20: 613
ZIRCONIUM NITRIDES
thermal properties to melting point, 20: 878
ZIRCONIUM OXIDES
crystal structure of films of, on zirconium surfaces, 20: 778
defect structure and electric conductivity of tetragonal, 20: 845
effects on grain boundary hardening in sintered beryllium oxide, 20: 846
fabrication of spherical particles of, by powder agglomeration method, 20: 793
stabilization by calcium oxide, effects of aluminum, iron, silicon, and titanium oxides on, 20: 867
thermal conductivity of stabilized, to 2200°C, 20: 820 (GE-TM-64-10-4)
use as support base for oxide catalyst for oxidation of internal combustion engine exhaust gases, 20: 343(P)
CaO–ZrO_2, preparation of dense and homogeneous samples by melting techniques, 20: 798
Y_2O_3–ZrO_2, preparation of dense and homogeneous samples by melting techniques, 20: 798
ZIRCONIUM SYSTEMS
C–Mo–Nb–Ta–W–Zr, erosion by sodium at 400, 1000, and 1500°F of Cb-132M, 20: 769(R) (NASA-CR-54459)
C–Mo–Nb–W–Zr, thermal properties to melting point, 20: 878
C–Mo–W–Zr, thermal properties to melting point, 20: 878
C–Nb–W–Y–Zr, corrosion by potassium at 2000°F of AS-55, 20: 768(R) (NASA-CR-54226)
C–Nb–W–Zr, corrosion by potassium at 2000°F of D-43, 20: 768(R) (NASA-CR-54226)
C–Nb–Zr, thermal properties to melting point, 20: 878
C–Ni–Zr, phase studies of nickel-rich, 20: 826 (NP-15535)

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5012	20-811	Dep.; BIS $0.30; HMSO 1s. 9d.
AERE-Trans–	(British)	
1031	20-834	BIS $0.50; HMSO 2s. 6d.
1035	20-835	BIS $0.30; HMSO 1s. 9d.
AFCRL–	(Non-AEC)	
65-480	20-1253	
AFOSR–	(Misc.)	
3147	20-959	See AD-613546
AHSB(S)–	(British)	
HANDBOOK-1 (1st. Rev.)	20-1410	Dep.; BIS $8.40; HMSO £2. 2s.
AI–	(Misc.)	
65-12	20-781	
AI-Trans–		
97	20-1121	Dep. mn; JCL $1.60 fs, $0.80 mf
ANL–		
7057	20-741	Dep. mn; CFSTI $1.00 cy, $0.50 mn
7058	20-742	Dep. mn; CFSTI $1.00 cy, $0.50 mn
ANL-Trans–		
225	20-485	Dep. mn; CFSTI $1.00 cy, $0.50 mn; JCL $1.10 fs, $0.80 mf
ARL–	(Non-AEC)	
65-151	20-1254	CFSTI
65-171	20-1255	CFSTI $3.00 cy, $0.75 mn
AROD–	(Misc.)	
2810.18	20-960	
AWRE-O–	(British)	
58/65	20-618	Dep.; BIS $1.40; HMSO 7s. 0d.
59/65	20-619	Dep.; BIS $0.90; HMSO 4s. 6d.
61/65	20-912	Dep.; BIS $1.40; HMSO 7s. 0d.
AWRE-R–	(British)	
3/65	20-1455	Dep.; BIS $1.80; HMSO 9s. 0d.
BM-RI–	(Misc.)	
6673	20-812	Bureau of Mines Free
BMI–	(Misc.)	
1731	20-888	Dep. mn; CFSTI $2.00 cy, $0.50 mn
BMI-X–		
276	20-457	Dep. mn; CFSTI $3.00 cy, $0.75 mn
BNL–		
939	20-743	Dep. mn; CFSTI $3.00 cy, $0.75 mn
8168	20-1145	Dep. mn; CFSTI $1.00 cy, $0.50 mn
8679	20-51	Radiat. Res., 26: 198-210(1965)
8828	20-1187	Nucl. Sci. Eng., 23: 238-50(1965)
9060	20-380	J. Phys. Chem., 69: 3547-51(1965)
9092	20-530	J. Geophys. Res., 70: 5309-11(1965)
9193	20-1019	Phys. Rev., 140: B730-5(1965)
9363	20-1	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9404	20-1558	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9475	20-1456	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9479	20-813	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9490	20-990	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9500	20-928	Dep. mn; CFSTI $5.00 cy, $1.00 mn
9514	20-929	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9543	20-649	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9553	20-930	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9554	20-931	Dep. mn; CFSTI $2.00 cy, $0.50 mn
9557	20-932	Dep. mn; CFSTI $1.00 cy, $0.50 mn
9573	20-1559	Dep. mn; CFSTI $1.00 cy, $0.50 mn
BNWL–		
69	20-429	Dep. mn; CFSTI $1.00 cy, $0.50 mn
120	20-744	Dep. mn; CFSTI $4.00 cy, $0.75 mn
125	20-763	Dep. mn; CFSTI $1.00 cy, $0.50 mn
126	20-1457	Dep. mn; CFSTI $3.00 cy, $0.50 mn
142	20-814	Dep. mn; CFSTI $1.00 cy, $0.50 mn
BNWL-SA–		
209	20-815	Dep. mn; CFSTI $2.00 cy, $0.50 mn
210	20-816	Dep. mn; CFSTI $1.00 cy, $0.50 mn
293	20-553	Dep. mn; CFSTI $1.00 cy, $0.50 mn
308	20-1458	Dep. mn; CFSTI $2.00 cy, $0.50 mn
313	20-764	Dep. mn; CFSTI $1.00 cy, $0.50 mn
CALT–		
68-44	20-1064	Phys. Rev., 140: B698-705(1965)
473-5	20-1560	Dep. mn; CFSTI $2.00 cy, $0.50 mn
CAPE–		
1080	20-800	
1142	20-634	
1183	20-494	
1204	20-342	
1206	20-220	
1210	20-727	
1214	20-639	
1218	20-635	
1227	20-673	
1232	20-717	
1239	20-675	
1240	20-726	
1244	20-428	
1248	20-672	
1256	20-638	
1267	20-221	
1285	20-1557	
1286	20-674	
1310	20-637	
1313	20-275	
1318	20-636	
CAR–		
882-12	20-1209	Phys. Rev., 140: B586-600(1965)

Report No.	Abstract No.	Availability
CEA-R–	(French)	
2760	20-223	Dep. mn
2823	20-430	Dep. mn
CEAL–		
1023	20-991	Dep. mn; CFSTI $1.00 cy, $0.50 mn
CEND–	(Misc.)	
512	20-1547	Dep. mn; CFSTI $3.00 cy, $0.50 mn
515	20-1459	Dep. mn; CFSTI $4.00 cy, $1.00 mn
CERN–	(European Organization for Nuclear Research)	
65-28	20-933	Dep. mn
CEX–		
59.4(Pt.3)	20-520	Dep. mn; CFSTI $1.00 cy, $0.75 mn
CNLM–	(Misc.)	
6352	20-224	Dep. mn; CFSTI $1.00 cy, $0.50 mn
CONF-284	20-631	(National Electronics Conference on Adaptive Processes, Chicago, Oct. 1963)
CONF-502–	(International Congress of Nuclear Physics, Paris, July 1964)	
23	20-1145	See BNL-8168
CONF-654	19-2907 19-6030	(American Nuclear Society Meeting, San Francisco, Nov. 30–Dec. 3, 1964) Proceedings
95	20-1307	See RRA-M45
CONF-679	20-1345 20-1346	(International Conference on the Physics of Semiconductors, Paris, July 1964)
CONF-710	20-817	(2nd International Symposium on Materials, Berkeley, Calif., June 15–18, 1964)
CONF-764–	(Thermal Conductivity Conference, San Francisco, Oct. 15, 1964)	
11	20-820	See GE-TM-64-10-4
CONF-620501 (Vol. I)	20-926	(1st Southeastern Conference on Theoretical and Applied Mechanics, Gatlinburg, Tenn., May 3–4, 1962)
CONF-630602	20-513	(International Conference on State of Stress in the Earth's Crust, Santa Monica, Calif., June 13–14, 1963)
CONF-631006–	(Symposium on Long-Term Aspects of the Development of Nuclear Energy in the European Community, Venice, Oct. 29–31, 1963)	
1	20-1463	See EUR-2445.f
CONF-631110–	(12th Meeting of the Italian Geophysics Assn., Rome, November 21–22, 1963)	
1	20-515	See RT/PROT(65)17
CONF-640412	20-877	(Conference on 5th Annual Structures and Materials, Palm Springs, Calif., Apr. 1–3, 1964)
CONF-640805–	(International Society of Hematology Congress, Stockholm, Aug. 30–Sept. 4, 1964)	
2	20-20	See EUR-2451.e
CONF-640811	20-943	(3rd Nordic-Dutch Accelerator Symposium, Hanko, Finland, Aug. 16–23, 1964)
CONF-640918–	(Symposium of High Energy Electrons, Montreux, Switzerland, Sept. 1964)	
2	20-162	Dep. mn; CFSTI $1.00 cy, $0.50 mn
CONF-641022–	(Optical Society of America, Annual Meeting, New York, Oct. 6–9, 1964)	
2	20-341	Gmelin, AED-CONF-64-227-2
CONF-650111–	(CERN Informal Neutrino Conference, Geneva, Jan. 1965)	
8	20-992	See COO-818-65
9	20-993	See COO-818-70
CONF-650118–	(Gordon Research Conference on Electro Chemistry, Santa Barbara, Calif., Jan. 28, 1965)	
1	20-290	See UCRL-11997
CONF-650326–	(Canadian Inst. of Mining and Metallurgy, 67th Annual General Meeting, Toronto, Ont., Canada, Mar. 29–31, 1965)	
1	20-450	Gmelin, AED-CONF-65-071-1
CONF-650407	20-554	(International Symposium on Fission Product Release and Transport Under Accident Conditions, Oak Ridge, Tenn., Apr. 1965)
CONF-650410–	(American Physical Society, Washington, D. C., Apr. 26–29, 1965)	
10	20-1252	Gmelin, AED-CONF-65-073-11
CONF-650413–	(Symposium on Neutron Dynamics and Control, Tucson, Ariz., Apr. 5–7, 1965)	
13	20-1411	Dep. mn; CFSTI $2.00 cy, $0.50 mn; Gmelin, AED-CONF-65-042-21
CONF-650428–	(Conference on Phenomena in the Neighborhood of the Critical Point, Washington, D. C., Apr. 5–8, 1965)	
3	20-1347	Gmelin, AED-CONF-65-078-6
CONF-650441–	(Aerospace Medical Assn., 36th Annual Scientific Meeting, New York, Apr. 26–29, 1965)	
2	20-614	Gmelin, AED-CONF-65-094-2
CONF-650443–	(Wistar Inst. Symposium on Human Leukemias, Philadelphia, Apr. 5–6, 1965)	
1	20-1	See BNL-9363
CONF-650502–	(Electrochemical Society, San Francisco, May 9–14, 1965)	
4	20-284	See EUR-804.e
10	20-285	See EUR-2496.e
CONF-650512	19-37944	(Symposium on Engineering Problems of Controlled Thermonuclear Research, Livermore, Calif., May 4–7, 1965)
13	20-1276	See ORNL-P-1511
15	20-505	See ORNL-P-1517
CONF-650524–	(European Nuclear Energy Agency and Atomic Energy Commission Seminar, Upton, N. Y., May 3–7, 1965)	
4	20-1160	See WAPD-T-1847
CONF-650532–	(Institute of Nuclear Materials Management Meeting, Cincinnati, May 10, 1965)	
2	20-1533	Dep. mn; CFSTI $1.00 cy, $0.50 mn
CONF-650540–	(American Industrial Hygiene Assn. Meeting, Houston, Tex., May 4–7, 1965)	
5	20-725	Gmelin, AED-CONF-65-116-8
6	20-927	Gmelin, AED-CONF-65-116-7
CONF-650549–	(International Atomic Energy Agency, Symposium on Exchange Reactions, Upton, N. Y., May 31–June 4, 1965)	
13	20-340	ORINS
CONF-650552–	(Institute of Food Technologists, 25th Annual Meeting, Kansas City, Mo., May 16–20, 1965)	
3	20-719	Gmelin, AED-CONF-65-111-3
4	20-718	Gmelin, AED-CONF-65-111-2
CONF-650556–	(Symposium on Electrical Methods and Principles in Molecular Biology, Jena, Germany, May 25–29, 1965)	
2	20-44	See COO-1148-98
CONF-650557–	(Conference on Boiling and Two Phase Flow for Heat Transfer Engineers, Berkeley/Los Angeles, Calif., May 27–28, 1965)	
1	20-489	Gmelin, AED-CONF-65-124-15
3	20-488	Gmelin, AED-CONF-65-124-16
4	20-487	Gmelin, AED-CONF-65-124-18
CONF-650562–	(Conference on Non-Equilibrium Thermodynamics, Chicago, May 17–19, 1965)	

Report No.	Abstract No.	Availability
1	20-1083	See MATT-368
CONF-650563–	(International Conference on the Internal Conversion Process, Nashville, Tenn., May 10–13, 1965)	
1	20-1159	See UCRL-16306
CONF-650602–	(American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn., June 20–24, 1965)	
60	20-724	Gmelin, AED-CONF-64-219-133
65	20-1543	Gmelin, AED-CONF-64-219-134
66	20-1516	Gmelin, AED-CONF-65-125-38
67	20-676	Gmelin, AED-CONF-64-219-137
69	20-1142	Gmelin, AED-CONF-64-219-136
CONF-650614–	(Symposium on the Use of Isotopes and Radiation in Soil-Plant Nutrition, Ankara, June 28–July 2, 1965)	
2	20-632	ORINS
3	20-633	ORINS
4	20-699	ORINS
CONF-650617–	(Vacuum Metallurgy Conference, New York, June 21–23, 1965)	
4	20-775	See SRIA-425-6, pp 10-33)
CONF-650634–	(16th Annual Mid-America Symposium on Spectroscopy, Chicago, June 14–17, 1965)	
2	20-229	See MLM-1289J
CONF-650652–	(International C-14 and H-3 Dating Conference, Pullman, Wash., June 7–11, 1965)	
5	20-519	Gmelin, AED-CONF-65-158-16
6	20-538	Gmelin, AED-CONF-65-158-8
CONF-650653–	(American Physical Society, Summer Meeting, New York, June 23–25, 1965)	
1	20-1132	Gmelin, AED-CONF-65-170-12
2	20-1251	Gmelin, AED-CONF-65-170-11
3	20-1052	Gmelin, AED-CONF-65-170-9
4	20-911	Gmelin, AED-CONF-65-170-13
5	20-1250	Gmelin, AED-CONF-65-170-10
CONF-650654–	(Ocean Science and Engineering Conference, Washington, D. C., June 14–17, 1965)	
1	20-551	Gmelin, AED-CONF-65-167-4
CONF-650656–	(International Symposium on Dynamics of Large-Scale Processes in the Atmosphere, Moscow, June 23–30, 1965)	
1	20-517	See UCRL-12415-T
CONF-650704–	(IAEA Symposium on Thermodynamics, Vienna, July 22–27, 1965)	
25	20-338	ORINS
33	20-283	See COO-1140-129
CONF-650710	19-43507	(American Nuclear Society, Meeting on Reactor Operating Experience, Jackson Lake Lodge, Wyo., July 28–30, 1965)
8	20-154	See RFP-621
CONF-650711–	(AIAA 2nd Annual Meeting and Technical Demonstration, San Francisco, July 26–29, 1965)	
14	20-502	ORINS
30	20-720	ORINS
31	20-721	ORINS
CONF-650714–	(International Club on Arterial Hypertension Symposium, Paris, July 5–7, 1965)	
1	20-1558	See BNL-9404
CONF-650803–	(IAEA Symposium on Nuclear Materials Management, Vienna, Aug. 30–Sept. 3, 1965)	
9	20-233	See SGAE-PH-28/1965
23	20-1440	ORINS
CONF-650806–	(7th International Conference on Phenomena in Ionized Gases, Belgrade, Aug. 22–27, 1965)	
10	20-1258	See LA-DC-7364
14	20-1280	See UCRL-16055
CONF-650810–	(Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 25–27, 1965)	
2	20-225	Dep. mn; CFSTI $1.00 cy, $0.50 mn
4	20-224	See CNLM-6352
CONF-650812–	(ASME–AIChE Heat Transfer Conference and Exhibit, Los Angeles, Aug. 8–11, 1965)	
12	20-492	ORINS
14	20-490	ORINS
15	20-491	ORINS
CONF-650821–	(Clay Minerals Society Meeting, Berkeley, Calif., Aug. 23–26, 1965)	
1	20-600	See ORNL-P-1581
CONF-650822–	(International Conference on Quantum Liquids, Brighton, Sussex, England, Aug. 1965)	
1	20-1118	See COO-1198-302
CONF-650824–	(Symposium on Liquid Helium, St. Andrews, Scotland, Aug. 26–28, 1965)	
1	20-1119	See LA-DC-7357
CONF-650908–	(International Conference on Thermionic Electrical Power Generation, London, Sept. 20–25, 1965)	
6	20-339	ORINS
CONF-650922–	(1st International Symposium on Magnet Technology, Stanford, Calif., Sept. 8–10, 1965)	
2	20-627	See UCRL-16357
10	20-939	See UCRL-16364
12	20-990	See BNL-9490
13	20-1279	See UCRL-14233
14	20-940	See UCRL-16382
15	20-932	See BNL-9557
CONF-650923–	(5th International Conference on High Energy Accelerators, Frascati, Italy, Sept. 9–16, 1965)	
6	20-929	See BNL-9514
12	20-649	See BNL-9543
CONF-650928–	(International Conference on Polarization Phenomena of Nucleons, Karlsruhe, Germany, Sept. 6–10, 1965)	
5	20-997	See ORNL-P-1607
6	20-1134	See ORNL-P-1604
7	20-1157	See ORNL-P-1616
CONF-650929–	(International Conference on Optical and Electronic Properties of Metals and Alloys, Paris, Sept. 13–16, 1965)	
2	20-1326	See ORNL-P-1600
CONF-650931–	(Explosives Safety Engineering Conference, Albuquerque, N. Mex., Sept. 28–29, 1965)	
1	20-594	See LA-DC-7469
CONF-650935–	(2nd IAEA Conference on Plasma Physics and Controlled Nuclear Fusion Research, Culham, England, Sept. 6–10, 1965)	
19	20-1260	See MATT-370
CONF-650936–	(1st International Symposium on Basic Problems in Thin Film Physics, Clausthal-Gottingen, Germany, Sept. 6–11, 1965)	
1	20-813	See BNL-9479
CONF-650938–	(2nd International Congress on Chemical Engineer Automation and Machinery, Prague, Sept. 1965)	
1	20-292	See UCRL-16173
CONF-650939–	(2nd International Symposium on Hyperpure Products in Science and Technology, Dresden, Germany, Sept. 28–Oct. 2, 1965)	
1	20-287	See ORNL-P-1611
CONF-650943–	(American Industrial Hygiene Assn., Industrial Medical Assn., and Health Physics Society, Gatlinburg, Tenn., Sept. 30–Oct. 1, 1965)	
1	20-592	See K-C-785
CONF-650944–	(Japan Atomic Industrial Forum, Tokyo, Sept. 19, 1965)	
1	20-1454	See AECL-2293
CONF-650946–	(4th High Temperature Liquid-Metal Heat Transfer	

Report No.	Abstract No.	Availability
	Technology Conference, Argonne, Ill., Sept. 28–29, 1965)	
1	20-482	See ORNL-P-1659
CONF-651001–	(IEEE Nuclear Science Symposium, San Francisco, Oct. 1965)	
3	20-651	See EGG-1183-2055
CONF-651002–	(Instrument Society of America, 20th Annual Conference, Los Angeles, Oct. 4–7, 1965)	
1	20-624	See SC-DC-65-1507
CONF-651004–	(9th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 12, 1965)	
2	20-235	See Y-KG-28
CONF-651008–	(Annual Bio-Assay Meeting, Albuquerque, N. Mex., Oct. 7–8, 1965)	
1	20-24	See RFP-640
CONF-651009–	(Conference on Safety, Fuels and Core Design in Large Fast Power Reactors, Argonne, Oct. 11–14, 1965)	
1	20-1456	See BNL-9475
CONF-651010–	(Electrochemical Society, 6th Regional AIChE Meeting, Union, Wash., Oct. 8, 1965)	
1	20-1551	See RL-SA-53
CONF-651011–	(IMOG and Metrology Subgroup Meeting, Las Vegas, Nov., Oct. 11, 1965)	
3	20-461	See RFP-667
CONF-651013–	(Shock and Vibration Symposium, New Orleans, Oct. 26–28, 1965)	
1	20-1566	See SC-DC-65-1545
CONF-651014–	(Western Industrial Health Conference, San Francisco, Oct. 8–9, 1965)	
1	20-553	See BNWL-SA-293
CONF-651016–	(35th Symposium on Shock and Vibration, New Orleans, Oct. 11, 1965)	
2	20-462	See SC-DC-65-1554
CONF-651017–	(Electrochemical Society Meeting, Buffalo, Oct. 10–14, 1965)	
1	20-1559	See BNL-9573
CONF-651018–	(Joint Electronics Fall and 8th Pacific Coast Regional Meeting, Los Angeles, Oct. 27–29, 1965)	
1	20-828	See SC-DC-65-1588
CONF-651020–	(5th Thermal Conductivity Conference, Denver, Oct. 20–22, 1965)	
1	20-823	See LA-DC-7456
4	20-827	See ORNL-P-1670
CONF-651021–	(25th National Convention of the Society for Nondestructive Testing, Detroit, Oct. 18–22, 1965)	
1	20-621	See LA-DC-6978
CONF-651101–	(American Nuclear Society, Winter Meeting, Washington, D. C., Nov. 15–18, 1965) (Revised 11–8–65)	
3	20-622	See LA-DC-7149
4	20-476	See LA-DC-7150
5	20-477	See ORNL-P-1385
35	20-1550	See RL-SA-50
CONF-651102–	(Royal Commonwealth Society, 3rd International Conference on Plutonium, London, Nov. 22–26, 1965)	
1	20-774	See RFP-609
5	20-816	See BNWL-SA-210
6	20-822	See LA-DC-7278
CONF-651103–	(IAEA Symposium on Criticality Control of Fissile Materials, Stockholm, Nov. 1–5, 1965)	
5	20-590	Dep. mn; CFSTI $2.00 cy, $0.50 mn
7	20-431	Dep. mn; CFSTI $1.00 cy, $0.50 mn
CONF-651105–	(Conference on Nuclear Electronics, Bombay, India, Nov. 22–26, 1965)	
1	20-1357	See ORNL-P-1432
CONF-651110–	(American Society of Mechanical Engineers, Annual Winter Meeting, Chicago, Nov. 7–11, 1965)	
4	20-460	See ORNL-P-1447
5	20-1349	See ORNL-TM-1274
CONF-651112–	(Meeting of Central Bureau of Nuclear Measurements, Brussels, Nov. 29–Dec. 3, 1965)	
1	20-228	See LA-DC-7439
CONF-651202–	(Symposium on Practices in the Treatment of Low and Intermediate Level Radioactive Waste, Vienna, Dec. 6–10, 1965)	
1	20-1548	See DPSPU-65-30-30
2	20-1552	See UCRL-14320
COO–		
401-118	20-620	Dep. mn; CFSTI $3.00 cy, $0.75 mn
614-37	20-732	Dep. mn; CFSTI $4.00 cy, $0.75 mn
720-053	20-1082	Dep. mn; CFSTI $4.00 cy, $1.00 mn
818-59	20-983	Dep. mn; CFSTI $4.00 cy, $0.75 mn
818-65	20-992	Dep. mn; CFSTI $1.00 cy, $0.50 mn
818-70	20-993	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1001-4	20-319	J. Inorg. Nucl. Chem., 27: 2183-92(1965)
1029-6	20-322	J. Phys. Chem., 69: 3514-19(1965)
1120-38	20-1146	Dep. mn; CFSTI $3.00 cy, $0.75 mn
1140-129	20-283	Dep. mn; CFSTI $2.00 cy, $0.50 mn
1148-98	20-44	Dep. mn; CFSTI $2.00 cy, $0.50 mn
1198-276	20-902	Phys. Rev., 140: A941-53(1965)
1198-302	20-1118	Dep. mn; CFSTI $3.00 cy, $0.75 mn
1233-21	20-1256	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1261-11	20-1015	Phys. Rev., 140: B685-7(1965)
1283-27	20-701	
CRRP–	(Canadian)	
1220	20-1147	Dep.; AECL $2.00
1222	20-1148	Dep.; AECL, $1.00 cy
CRT–	(Canadian)	
1167	20-733	Dep.; AECL $1.50
CU–	(Misc.)	
1019-47	20-1213	Phys. Rev., 140: B623-30(1965)
CVNA–	(Misc.)	
243	20-1462	Dep. mn; CFSTI $2.00 cy, $0.50 mn
DP–		
943	20-782	Dep. mn; CFSTI $2.00 cy, $0.50 mn
DPSPU–		
65-30-30	20-1548	Dep. mn; CFSTI $1.00 cy, $0.50 mn
DUBNA REPORTS	(Russian)	
See JINR (Russian)		
EANDC-US–	(European-American Nuclear Data Committee)	
73(U)	20-1161	See WASH-1057
EGG–		
1183-2055	20-651	Dep. mn; CFSTI $1.00 cy, $0.50 mn
EUR–	(European Atomic Energy Community)	
804.e	20-284	Dep. mn
1845.f	20-344	Dep. mn
2167.d	20-510	Dep. mn
2323	20-818	See EURAEC-1348
2348	20-765	See EURAEC-1387
2371	20-1324	See EURAEC-1428
2379	20-766	See EURAEC-1445
2419.f	20-2	Dep. mn
2439.f	20-1277	See TID-22136
2445.f	20-1463	Dep. mn
2450.d	20-345	Dep. mn
2451.e	20-20	Dep. mn
2460.d,f,i,n	20-144	Dep. mn
2469.f	20-55	Dep. mn
2471.f	20-45	Dep. mn
2496.e	20-285	Dep. mn
EURAEC–		
1348	20-818	Dep. mn; CFSTI $2.00 cy, $0.50 mn

Report No.	Abstract No.	Availability
1387	20-765	Dep. mn; CFSTI $3.00 cy, $0.75 mn
1391	20-747	Dep. mn; CFSTI $2.00 cy, $0.50 mn
1402	20-432	Dep. mn; CFSTI $3.00 cy, $0.50 mn
1428	20-1324	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1431	20-888	See BMI-1731
1445	20-766	Dep. mn; CFSTI $4.00 cy, $1.00 mn
1469	20-1436	See GEAP-4907
1470	20-767	See GEAP-4915
1478	20-893	See GEAP-5100A
EXP-NRX–	**(Canadian)**	
21406	20-890	Dep.; AECL $0.50
F–	**(Misc.)**	
A2392-3	20-458	See NYO-2512-15
FD–	**(Non-AEC)**	
24	20-700	See AD-621921
FTD-TT–	**(Non-AEC)**	
65-599	20-1162	See AD-619487
65-613	20-789	See AD-619333
65-629	20-1281	See AD-620824
FZK–	**(Non-AEC)**	
201	20-1303	See AD-614250
210	20-1144	See AD-614451
GA–	**(Misc.)**	
4554(Rev.)	20-722	Dep. mn; CFSTI $4.00 cy, $0.75 mn
6312	20-241	Anal. Chem., 37: 1405-8(1965)
6413	20-819	Dep. mn; CFSTI $2.00 cy, $0.50 mn
GAMD–	**(Misc.)**	
6364	20-1464	Dep. mn; CFSTI $1.00 cy, $0.50 mn
6507	20-1149	Dep. mn; CFSTI $1.00 cy, $0.50 mn
6623	20-591	Dep. mn; CFSTI $1.00 cy, $0.50 mn
GAT-L–		
420	20-346	Dep. mn; CFSTI $1.00 cy, $0.50 mn
GE-TM–		
64-10-4	20-820	Dep. mn; CFSTI $1.00 cy, $0.50 mn
65-10-1	20-821	Dep. mn; CFSTI $1.00 cy, $0.50 mn
GEAP–	**(Misc.)**	
3893	20-891	Dep. mn; CFSTI $3.00 cy, $0.75 mn
4804	20-892	Dep. mn; CFSTI $3.00 cy, $0.75 mn
4894	20-1465	Dep. mn; CFSTI $2.00 cy, $0.50 mn
4907	20-1436	Dep. mn; CFSTI $3.00 cy, $0.75 mn
4915	20-767	Dep. mn; CFSTI $3.00 cy, $0.75 mn
5100A	20-893	Dep. mn; CFSTI $5.00 cy, $1.00 mn
GEST–	**(Misc.)**	
2047	20-1437	
HASL–		
164	20-521	Dep. mn; CFSTI $7.00 cy, $1.50 mn
HPR–	**(Norwegian)**	
63	20-1466	Dep. mn
HW-SA–		
3559	20-660	Health Phys., 11: 1221-4(1965)
3686	20-659	Health Phys., 11: 1213-19(1965)
IA–	**(Non-AEC)**	
989	20-145	Dep. mn
1016	20-256	Israel J. Chem., 3: 47-55(1965)
IAE–	**(Non-AEC)**	
574	20-984	Dep. mn
769	20-1257	Dep. mn
IDO–		
17075	20-1133	Dep. mn; CFSTI $1.00 cy, $0.50 mn
17109	20-1412	Dep. mn; CFSTI $4.00 cy, $1.00 mn
28649	20-1467	Dep. mn; CFSTI $4.00 cy, $0.75 mn
IFA-FT–	**(Rumanian)**	
55	20-1150	Dep. mn
IFA-RN–	**(Rumanian)**	
20	20-1151	Dep. mn
21	20-1152	Dep. mn
INP–	**(Polish)**	
412/C	20-433	Dep.
INR–	**(Non-AEC)**	
605/VII/PL	20-1153	Dep.
647/I-A,VI/PH	20-652	Dep.
IS–		
1100	20-851	J. Phys. Chem. Solids, 26: 1475-88(1965)
1130	20-240	Anal. Chem., 37: 1358-61(1965)
1180	20-1174	Nucl. Phys., 74: 110-12(1965)
1227	20-783	Dep. mn; CFSTI $1.00 cy, $0.50 mn
IS-T–		
31	20-1561	Dep. mn; CFSTI $5.00 cy, $1.00 mn
39	20-226	Dep. mn; CFSTI $3.00 cy, $0.50 mn
IS-Trans–		
20	20-755	Dep. mn; JCL $1.60 fs, $0.80 mf
ISS–	**(Italian)**	
65/4	20-934	Dep. mn
JINR–	**(Russian)**	
P-1988	20-734	Dep. mn
P-2306	20-1110	Dep. mn
P-2321	20-1053	Dep. mn
P-2323	20-1154	Dep. mn
P-2328	20-1054	Dep. mn
P-2332	20-994	Dep. mn
P-2337	20-995	Dep. mn
P-2338	20-1055	Dep. mn
P-2347	20-1155	Dep. mn
P-2370	20-1156	Dep. mn
JPL-TR–	**(Non-AEC)**	
32-741	20-1468	
JPRS–	**(Non-AEC)**	
24452	20-165	See N64-20943
31526	20-1352	CFSTI $3.00 cy, $0.75 mn
31646	20-155	CFSTI $1.00 cy, $0.50 mn
31747	20-602	CFSTI $1.00 cy, $0.50 mn
JüL–	**(German)**	
248-NP	20-434	Dep. mn
K-C–		
785	20-592	Dep. mn; CFSTI $1.00 cy, $0.50 mn
KAPL-M–		
6448	20-227	Dep. mn; CFSTI $2.00 cy, $0.50 mn
KFK–	**(German)**	
359	20-1469	Dep. mn
KRB–	**(German)**	
1964/4	20-1475	See TID-22223
KY–		
500	20-593	Dep. mn; CFSTI $3.00 cy, $0.75 mn
LA–		
3370	20-1534	Dep. mn; CFSTI $3.00 cy, $0.75 mn
LA-DC–		
6479	20-658	Health Phys., 11: 1127-44(1965)
6479(Rev.)	20-658	See LA-DC-6479
6676	20-972	Phys. Rev., 140: A721-6(1965)
6978	20-621	Dep. mn; CFSTI $1.00 cy, $0.50 mn
6982	20-864	Phys. Status Solidi, 11: 595-602(1965)
7149	20-622	Dep. mn; CFSTI $1.00 cy, $0.50 mn
7150	20-476	Dep. mn; CFSTI $1.00 cy, $0.50 mn
7242	20-310	J. Chem. Phys., 43: 2904-6(1965)
7263	20-1216	Phys. Rev., 140: B648-54(1965)
7278	20-822	Dep. mn; CFSTI $2.00 cy, $0.50 mn
7357	20-1119	Dep. mn; CFSTI $2.00 cy, $0.50 mn
7364	20-1258	Dep. mn; CFSTI $1.00 cy, $0.50 mn

Report No.	Abstract No.	Availability
7439	20-228	Dep. mn; CFSTI $1.00 cy, $0.50 mn
7456	20-823	Dep. mn; CFSTI $2.00 cy, $0.50 mn
7457	20-1340	Phys. Rev. Lett., 15: 722-4(1965)
7469	20-594	Dep. mn; CFSTI $1.00 cy, $0.50 mn
LAL–	**(French)**	
1142	20-913	Dep. mn
1143	20-653	Dep. mn
LF–		
23	20-3	Dep. mn; CFSTI $2.00 cy, $0.50 mn
26	20-4	Dep. mn; CFSTI $0.50 cy, $0.50 mn
MATT–		
366	20-1259	Dep. mn; CFSTI $1.00 cy, $0.50 mn
368	20-1083	Dep. mn; CFSTI $1.00 cy, $0.50 mn
370	20-1260	Dep. mn; CFSTI $2.00 cy, $0.50 mn
ML–	**(Misc.)**	
1184	20-1261	Dep. mn; CFSTI $3.00 cy, $0.75 mn
MLM–		
1275	20-595	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1289J	20-229	Dep. mn; CFSTI $2.00 cy, $0.50 mn
N–	**(Misc.)**	
64-20943	20-165	CFSTI $1.50 cy, $0.75 mn
NAA-SR–		
9778	20-1527	Dep. mn; CFSTI $3.00 cy, $0.75 mn
11207	20-1528	Dep. mn; CFSTI $2.00 cy, $0.50 mn
NAA-SR-Memo–		
10961	20-1529	Dep. mn; CFSTI $1.00 cy, $0.50 mn
11194	20-481	Dep. mn; CFSTI $2.00 cy, $0.50 mn
NADC-EL–	**(Non-AEC)**	
6504	20-646	See AD-614432
NASA-CR–	**(Misc.)**	
309	20-1262	CFSTI $4.00 cy, $1.00 mn
312	20-692	CFSTI $3.00 cy, $0.75 mn
54136	20-498	
54226	20-768	
54316	20-781	See AI-65-12
54458	20-824	
54459	20-769	
54477	20-770	
NASA-SP–	**(Misc.)**	
7011(15)	20-56	CFSTI $1.00 cy, $1.00 mn
NASA-TM–	**(Misc.)**	
X-1140	20-1306	CFSTI $2.00 cy, $0.50 mn
NASA-TN–	**(Misc.)**	
D-2950	20-914	CFSTI $3.00 cy, $0.75 mn
NBS–	**(Misc.)**	
8817	20-1263	Dep. mn; CFSTI $2.00 cy, $0.50 mn
8843	20-1264	Dep. mn; CFSTI $6.00 cy, $1.50 mn
8846	20-1265	Dep. mn; CFSTI $3.00 cy, $0.75 mn
NIJS-R–	**(Yugoslavian)**	
446	20-217	Dep. mn
NLCO–		
965	20-748	Dep. mn; CFSTI $2.00 cy, $0.50 mn
NP–	**(AEC File No. for Non-AEC Reports)**	
15172	20-693	Dep. mn
15204	20-996	Dep. mn
15344	20-231	Dep. mn
15407	20-1470	Dep. mn
15450	20-1266	Dep. mn
15453	20-1325	Dep. mn
15466	20-654	Dep. mn
15517	20-951	Dep. mn
15525	20-416	Dep. mn
15529	20-623	Dep. mn
15531	20-723	Dep. mn
15534	20-552	Dep. mn
15535	20-826	Bureau of Mines and Technical Surveys, Ottawa $0.50
15536	20-1056	Dep. mn
15541	20-499	
15542	20-596	Dep. mn
15557	20-542	
15558	20-771	
15563	20-597	Dep. mn
15568	20-598	Dep. mn
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
1266	20-237	Dep. mn; JCL $1.10 fs, $0.80 mf
1293	20-238	Dep. mn; JCL $1.60 fs, $0.80 mf
1299	20-358	Dep. mn; JCL $2.60 fs, $1.07 mf
NRL–	**(Misc.)**	
6233	20-286	CFSTI $3.00 cy, $0.75 mn
6288	20-735	
6306	20-599	Dep. mn; CFSTI $1.00 cy, $0.50 mn
NVO–		
98-9	20-543	Dep. mn; $3.00 cy, $0.75 mn
NYO–		
901-37	20-5	Dep. mn; CFSTI $4.00 cy, $0.75 mn
2391-10	20-1339	Phys. Rev., 140: A1030-?(1965)
2512-15	20-458	Dep. mn; CFSTI $2.00 cy, $0.50 mn
2598-25	20-21	Dep. mn; CFSTI $3.00 cy, $0.75 mn
2684-39	20-1562	Dep. mn; CFSTI $1.00 cy, $0.50 mn
2807-14	20-387	Nucl. Sci. Eng., 23: 299-305(1965)
2813-34	20-1267	Dep. mn; CFSTI $2.00 cy, $0.50 mn
2978-42	20-355	Dep. mn; CFSTI $3.00 cy, $0.50 mn
3086-1	20-146	Dep. mn; CFSTI $4.00 cy, $1.00 mn
3257-1	20-772	Dep. mn; CFSTI $3.00 cy, $0.75 mn
3319-7	20-6	Dep. mn; CFSTI $1.00 cy, $0.50 mn
3337-16	20-702	Dep. mn; CFSTI $1.00 cy, $1.50 mn
ORNL–		
3811	20-1549	Dep. mn; CFSTI $2.00 cy, $0.50 mn
3817	20-459	Dep. mn; CFSTI $3.00 cy, $0.50 mn
3829	20-696	Dep. mn; CFSTI $2.00 cy, $0.50 mn
3836	20-1268	Dep. mn; CFSTI $5.00 cy, $1.00 mn
3859	20-773	Dep. mn; CFSTI $2.00 cy, $0.50 mn
3883	20-7	Dep. mn; CFSTI $2.00 cy, $0.50 mn
ORNL-AMPIC–		
2	20-1563	ORNL Free
ORNL-P–	**(Misc.)**	
928	20-88	Int. J. Radiat. Biol., 9: 391-7(1965)
1091	20-605	Health Phys., 11: 1163-75(1965)
1105	20-898	Nature, 208: 73-4(1965)
1279	20-758	J. Amer. Ceram. Soc., 48: 494-5(1965)
1385	20-477	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1432	20-1357	Dep. mn; CFSTI $2.00 cy, $0.50 mn
1445	20-98	Nature, 208: 36-7(1965)
1447	20-460	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1469	20-1215	Phys. Rev., 140: B638-47(1965)
1511	20-1276	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1517	20-505	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1581	20-600	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1600	20-1326	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1604	20-1134	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1607	20-997	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1611	20-287	Dep. mn; CFSTI $2.00 cy, $0.50 mn
1616	20-1157	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1659	20-482	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1670	20-827	Dep. mn; CFSTI $3.00 cy, $0.50 mn
ORNL-TM–		
1166	20-915	Dep. mn; CFSTI $2.00 cy, $0.50 mn
1252	20-786	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1264	20-288	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1274	20-1349	Dep. mn; CFSTI $2.00 cy, $0.50 mn
1275	20-469	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1282	20-1471	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1296	20-1158	Dep. mn; CFSTI $1.00 cy, $0.50 mn
1298	20-935	Dep. mn; CFSTI $1.00 cy, $0.50 mn
ORNL-tr–		
893	20-439	Dep. mn; CFSTI $1.00 cy, $0.50 mn; JCL $1.60 fs, $0.80 mf

Report No.	Abstract No.	Availability
ORO–		
629	20-1564	Dep. mn; CFSTI $2.00 cy, $0.50 mn
OTS–	**(Misc.)**	
64-31197	20-165	See N64-20943
PATENTS	**(British)**	**(4s. 6d. each, U. K. Patent Office)**
1,002,069	20-615	
1,002,244	20-1441	
1,002,625	20-1368	
1,002,784	20-1442	
1,002,861	20-1517	
1,003,020	20-1369	
1,003,179	20-616	
1,003,215	20-1370	
1,003,220	20-677	
1,003,410	20-1371	
1,003,446	20-1443	
1,003,723	20-1372	
1,003,826	20-1424	
1,003,827	20-1425	
1,005,134	20-728	
1,005,177	20-1373	
1,005,285	20-1374	
PATENTS	**(French)**	
1,246,247	20-1375	
1,261,675	20-1444	
1,294,305	20-1376	
1,329,607	20-1377	
1,334,563	20-1378	
1,334,833	20-1379	
1,342,721	20-1380	
1,343,522	20-1323	
1,345,789	20-1381	
1,348,527	20-1544	
1,362,884	20-1382	
1,365,782	20-1426	
1,366,384	20-1383	
1,371,463	20-1384	
1,374,606	20-1385	
1,376,249	20-1386	
1,378,516	20-1387	
1,382,728	20-1427	
1,383,260	20-1545	
PATENTS	**(German)**	
1,192,336	20-1388	
1,192,633	20-451	
1,192,634	20-276	
1,192,659	20-1518	
1,192,828	20-801	
1,193,681	20-761	
1,193,962	20-1525	
1,194,068	20-678	
1,194,069	20-679	
1,194,071	20-1389	
1,194,072	20-1390	
1,194,511	20-1445	
1,194,582	20-452	
1,195,415	20-680	
1,195,416	20-681	
1,195,731	20-453	
1,195,876	20-1391	
1,195,877	20-1446	
1,195,878	20-1447	
1,195,880	20-1519	
1,196,305	20-1392	
1,196,377	20-454	
1,196,800	20-1448	
1,197,995	20-945	
1,198,799	20-729	
1,198,943	20-1526	
1,198,944	20-1394	
1,199,748	20-455	
1,199,894	20-682	
1,199,895	20-1520	
1,199,896	20-1393	
1,199,900	20-946	
1,199,901	20-947	
1,200,446	20-683	
1,200,447	20-503	
1,200,448	20-730	
1,200,449	20-1449	
1,200,451	20-1395	
1,200,452	20-1396	
PATENTS	**(U. S.)**	**($0.25 each, U. S. Patent Office)**
3,196,272	20-640	
3,197,184	20-479	
3,197,634	20-641	
3,201,589	20-684	
3,202,581	20-1428	
3,202,582	20-1532	
3,202,583	20-1450	
3,202,597	20-415	
3,202,618	20-343	
3,202,819	20-685	
3,203,866	20-1397	
3,203,867	20-1429	
3,204,099	20-686	
3,205,138	20-1521	
3,205,140	20-1430	
3,205,141	20-1398	
3,205,143	20-1399	
3,205,144	20-1431	
3,205,145	20-1432	
3,205,146	20-1433	
3,205,147	20-1400	
3,205,564	20-1143	
3,206,366	20-1401	
3,206,367	20-1402	
3,206,368	20-1403	
3,206,369	20-1451	
3,206,370	20-1434	
3,206,372	20-1522	
3,206,373	20-1404	
3,206,374	20-1405	
3,206,671	20-642	
3,207,668	20-1406	
3,207,669	20-1407	
3,207,670	20-1435	
3,207,895	20-643	
3,207,902	20-687	
3,207,938	20-688	
3,208,159	20-689	
3,209,145	20-690	
3,209,151	20-691	
3,209,269	20-948	
3,210,852	20-644	
3,211,478	20-468	
3,211,526	20-1578	
3,211,602	20-1579	
3,211,628	20-802	
3,211,664	20-803	
3,211,812	20-804	
3,211,884	20-805	
3,211,947	20-509	
3,212,035	20-645	
3,212,036	20-949	
3,212,940	20-1580	
3,212,975	20-1408	
3,212,982	20-1546	
3,212,986	20-1523	
3,212,987	20-1524	
3,212,991	20-1409	
3,213,002	20-456	
3,213,032	20-806	
3,213,161	20-807	
3,213,162	20-808	
3,213,163	20-809	
3,213,379	20-950	
PHS–	**(Misc.)**	
999-RH-15	20-655	Public Health Service Free
PNE–		
505P	20-511	Dep. mn; CFSTI $1.00 cy, $1.00 mn
1000	20-470	Dep. mn; CFSTI $1.00 cy, $0.75 mn
1999	20-471	Dep. mn; CFSTI $1.00 cy, $0.50 mn
2005	20-472	Dep. mn; CFSTI $1.00 cy, $0.75 mn
2006	20-473	Dep. mn; CFSTI $1.00 cy, $0.50 mn
PPAD–		

Report No.	Abstract No.	Availability
2137-553	20-1205	Phys. Rev., 140: B559-62(1965)
PRNC–		
40	20-46	Dep. mn; CFSTI $2.00 cy, $0.50 mn
PUC–		
1963-112	20-967	J. Math. Anal. Appl., 11: 338-49(1965)
1965-160	20-1208	Phys. Rev., 140: B575-85(1965)
1965-161	20-1186	Nucl. Phys., 74: 234-40(1965)
1965-162	20-1204	Phys. Rev., 140: B555-8(1965)
R–	(Misc.)	
142	20-826	See NP-15535
RCC-R–	(British)	
176(Add.)	20-601	Dep.; BIS
RFP–		
441	20-259	J. Inorg. Nucl. Chem., 27: 2151-60(1965)
543	20-751	Dep. mn; CFSTI $1.00 cy, $0.50 mn
551	20-435	Dep. mn; CFSTI $2.00 cy, $0.50 mn
609	20-774	Dep. mn; CFSTI $1.00 cy, $0.50 mn
621	20-154	Dep. mn; CFSTI $2.00 cy, $0.50 mn
623	20-787	Dep. mn; CFSTI $1.00 cy, $0.50 mn
640	20-24	Dep. mn; CFSTI $1.00 cy, $0.50 mn
667	20-461	Dep. mn; CFSTI $1.00 cy, $0.50 mn
RL-SA–		
39	20-759	Nucl. Struct. Eng., 2: 181-202(1965)
50	20-1550	Dep. mn; CFSTI $1.00 cy, $0.50 mn
53	20-1551	Dep. mn; CFSTI $2.00 cy, $0.50 mn
RL-SEP–		
503	20-752	Dep. mn; CFSTI $2.00 cy, $0.50 mn
518	20-436	Dep. mn; CFSTI $2.00 cy, $0.50 mn
RPI–	(Misc.)	
1999-6	20-1565	Dep. mn; CFSTI $1.00 cy, $0.50 mn
RRA–	(Misc.)	
M45	20-1307	Dep. mn; CFSTI $2.00 cy, $0.50 mn
T41	20-1308	Dep. mn; CFSTI $4.00 cy, $1.00 mn
T46	20-1309	Dep. mn; CFSTI $3.00 cy, $0.50 mn
T51	20-1310	Dep. mn; CFSTI $4.00 cy, $1.00 mn
RT-CHI–	(Italian)	
(65)21	20-437	Dep. mn
(65)23	20-438	Dep. mn
(65)27	20-894	Dep. mn
RT-FI–	(Italian)	
(65)12	20-1135	Dep. mn
RT-FIMA–	(Italian)	
(65)2	20-1311	Dep. mn
RT-ING–	(Italian)	
(64)12	20-1472	Dep. mn
(64)12bis	20-1473	Dep. mn
(65)4	20-1413	Dep. mn
RT-PROT–	(Italian)	
(65)17	20-515	Dep. mn
S–	(Misc.)	
224-R	20-520	See CEX-59.4(Pt.3)
SB–	(Non-AEC)	
415(Suppl.1)	20-753	CFSTI Free
SC-DC–		
65-1507	20-624	Dep. mn; CFSTI $1.00 cy, $0.50 mn
65-1545	20-1566	Dep. mn; CFSTI $2.00 cy, $0.50 mn
65-1554	20-462	Dep. mn; CFSTI $2.00 cy, $0.50 mn
65-1588	20-828	Dep. mn; CFSTI $2.00 cy, $0.50 mn
65-1634	20-463	Dep. mn; CFSTI $1.00 cy, $0.50 mn
SC-RR–		
65-380	20-1567	Dep. mn; CFSTI $1.00 cy, $0.50 mn
SC-TM–		
65-268	20-625	Dep. mn; CFSTI $1.00 cy, $0.50 mn
SCL-DC–		
65-92	20-626	Dep. mn; CFSTI $6.00 cy, $1.25 mn
SGAE-CH–	(Austrian)	
19/1965	20-356	Dep. mn
SGAE-PH–	(Austrian)	
28/1965	20-233	Dep. mn
SGAE-RE–	(Austrian)	
3/1965	20-233	See SGAE-PH-28/1965
SIT–	(Misc.)	
166	20-1267	See NYO-2813-34
SLAC–		
41	20-936	Dep. mn; CFSTI $3.00 cy, $0.75 mn
45	20-937	Dep. mn; CFSTI $4.00 cy, $0.75 mn
46	20-938	Dep. mn; CFSTI $3.00 cy, $0.50 mn
SM–	(Misc.)	
66/72	20-283	See COO-1140-129
70/30	20-590	See CONF-651103-5
70/40	20-431	See CONF-651103-7
SRIA–		
425-6	20-916	Dep. mn; CFSTI $2.00 cy, $0.50 mn
STI-DOC–	(International Atomic Energy Agency)	
10/42	20-1568	IAEA US $1.00; S 21,-; 6/-stg; F.Fr.4,-; DM 3,20
SU–	(Misc.)	
247-9	20-1084	Dep. mn; CFSTI $3.00 cy, $0.75 mn
SWRI–		
1228-73	20-788	Dep. mn; CFSTI $3.00 cy, $0.75 mn
SZS–	(German)	
5(1965)	20-64	Dep. mn
TID–		
3077(Suppl.1)	20-164	Dep. mn; CFSTI $6.00 cy, $1.25 mn
3731	20-1569	DTI Extension Free
4100(Suppl.29)	20-464	Dep.; DTI Extension Free
21261	20-10	Dep. mn; CFSTI $2.00 cy, $0.50 mn
21358	20-289	Dep. mn; CFSTI $1.00 cy, $0.50 mn
21519	20-896	Acta Met., 13: 1123-30(1965)
21567	20-1342	Z. Phys., 188: 139-53(1965)
21854	20-121	Radiol. Clin. N. Am., 209-17(1965)
21915	20-1212	Phys. Rev., 140: B616-22(1965)
22136	20-1277	Dep. mn; CFSTI $6.00 cy, $1.25 mn
22150	20-1570	Dep. mn; CFSTI $4.00 cy, $1.00 mn
22174	20-65	Dep. mn; CFSTI $1.00 cy, $0.50 mn
22186	20-1571	Dep. mn; CFSTI $1.00 cy, $0.50 mn
22196	20-1572	Dep. mn; CFSTI $3.00 cy, $0.75 mn
22223	20-1475	Dep. mn; CFSTI $4.00 cy, $0.75 mn
22224	20-483	Dep. mn; CFSTI $2.00 cy, $0.50 mn
22251	20-347	Dep. mn; CFSTI $2.00 cy, $0.50 mn
22255	20-998	Dep. mn; CFSTI $3.00 cy, $0.75 mn
22273	20-1278	Dep. mn; CFSTI $1.00 cy, $0.50 mn
22275	20-829	Dep. mn; CFSTI $2.00 cy, $0.50 mn
22277	20-917	Dep. mn; CFSTI $2.00 cy, $0.50 mn
22278	20-516	Dep. mn; CFSTI $4.00 cy, $0.75 mn
22282	20-484	Dep. mn; CFSTI $1.00 cy, $0.50 mn
22288	20-1476	Dep. mn; CFSTI $3.00 cy, $0.75 mn
22292	20-66	Dep. mn; CFSTI $2.00 cy, $0.50 mn
22294	20-25	Dep. mn; CFSTI $1.00 cy, $0.50 mn
22313	20-963	Dep. mn; CFSTI $1.00 cy, $0.50 mn
22314	20-1573	Dep. mn; CFSTI $1.00 cy, $0.50 mn
22322	20-26	Dep. mn; CFSTI $2.00 cy, $0.50 mn
TIM–	(Misc.)	
822	20-776	Dep. mn; CFSTI $1.00 cy, $0.50 mn
950	20-1350	Dep. mn; CFSTI $1.00 cy, $0.50 mn
TPR–	(Non-AEC)	
467-3	20-769	See NASA-CR-54459
TRG-Report–	(British)	
982	20-279	See CONF-650407, pp 853-68)

Report No.	Abstract No.	Availability
TT–	(Canadian)	
65-32022	20-1352	See JPRS-31526
65-32141	20-155	See JPRS-31646
65-32242	20-602	See JPRS-31747
UCLA–		
12-538	20-32	Health Phys., 11: 1187-94(1965)
UCRL–		
10701(Rev.)	20-882	pp 12-103 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965
10701(Rev.2)	20-882	pp 12-103 of High-Strength Materials. New York, John Wiley and Sons, Inc., 1965
11947	20-1211	Phys. Rev., 140: B605-15(1965)
11997	20-290	Dep. mn; CFSTI $4.00 cy, $0.75 mn
12376	20-1217	Phys. Rev. Lett., 15: 727-30(1965)
12415-T	20-517	Dep. mn; CFSTI $1.00 cy, $0.50 mn
13156	20-1574	Dep. mn; CFSTI $1.00 cy, $0.50 mn
14139	20-965	J. Chem. Phys., 43: 3055-7(1965)
14187	20-973	Phys. Rev., 140: A726-9(1965)
14211	20-613	Science, 150: 489-93(1965)
14215	20-830	Dep. mn; CFSTI $2.00 cy, $0.50 mn
14233	20-1279	Dep. mn; CFSTI $1.00 cy, $0.50 mn
14274	20-831	Dep. mn; CFSTI $2.00 cy, $0.50 mn
14320	20-1552	Dep. mn; CFSTI $1.00 cy, $0.50 mn
14379	20-291	Dep. mn; CFSTI $4.00 cy, $0.75 mn
14386	20-1191	Phys. Lett., 19: 226-8(1965)
16012	20-1338	Phys. Rev., 140: A1020-3(1965)
16054	20-974	Phys. Rev., 140: A729-31(1965)
16055	20-1280	Dep. mn; CFSTI $1.00 cy, $0.50 mn
16064	20-1214	Phys. Rev., 140: B630-7(1965)
16111	20-796	Powder Met., 8: 351-65(1965)
16112	20-1012	Phys. Rev., 140: B663-8(1965)
16121	20-754	Dep. mn; CFSTI $3.00 cy, $0.75 mn
16173	20-292	Dep. mn; CFSTI $1.00 cy, $0.50 mn
16180	20-832	Dep. mn; CFSTI $3.00 cy, $0.75 mn
16306	20-1159	Dep. mn; CFSTI $1.00 cy, $0.50 mn
16330	20-293	Dep. mn; CFSTI $3.00 cy, $0.75 mn
16357	20-627	Dep. mn; CFSTI $1.00 cy, $0.50 mn
16364	20-939	Dep. mn; CFSTI $1.00 cy, $0.50 mn
16366	20-1057	Dep. mn; CFSTI $3.00 cy, $0.75 mn
16382	20-940	Dep. mn; CFSTI $1.00 cy, $0.50 mn
16404	20-1009	Phys. Rev. Lett., 15: 734-6(1965)
16409	20-1575	Dep. mn; $6.00 cy, $1.25 mn
UCRL-Trans–		
1213(L)	20-836	Dep. mn; JCL $1.60 fs, $0.80 mf
1239(L)	20-294	Dep. mn; CFSTI $1.00 cy, $0.50 mn; JCL $1.60 fs, $0.80 mf
UR–		
875-85	20-1069	Phys. Rev., 140: B804-?(1965)
USNRDL-TR–	(Misc.)	
896	20-357	
WAPD-PWR–		
TE-166	20-1477	Dep. mn; CFSTI $2.00 cy, $0.50 mn
WAPD-T–		
1724	20-1415	J. Math. Anal. Appl., 11: 538-47(1965)
1818	20-1136	Nucl. Sci. Eng., 23: 234-7(1965)
1847	20-1160	Dep. mn; CFSTI $1.00 cy, $0.50 mn
WASH–		
1057	20-1161	Dep. mn; CFSTI $3.00 cy, $0.75 mn
1060	20-1351	Dep. mn; GPO $0.50 cy
WERL–	(Misc.)	
8844-5	20-833	Dep. mn; CFSTI $1.00 cy, $0.50 mn
WL-TR–	(Non-AEC)	
64-140	20-1144	See AD-614451
64-151	20-1303	See AD-614250
Y-KG–		
28	20-235	Dep. mn; CFSTI $1.00 cy, $0.50 mn

Appendix I

NUCLEAR SCIENCE ABSTRACTS CATEGORY DEFINITIONS

BIOLOGY AND MEDICINE

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Ecology

Movement of radioactive and other materials through organisms and the environment and influence of these materials on natural communities. The measurement and hazards of radioactive materials in the biosphere are included in the subcategory *Radiation Hazards and Protection* of this category.

Metabolism, Tissue Distribution, and Toxicology

Chemical and metabolic processes in living organisms and the absorption, metabolism, utilization, and toxicological significance of materials ingested, inhaled, or otherwise entering the organisms. Studies performed to establish maximum allowable concentrations of radioactive materials are included in the subcategory *Radiation Hazards and Protection* of this category.

Radiation Effects on Biochemicals

Radiation effects on biochemical materials such as enzymes, DNA, biological extracts, etc.

Radiation Effects on Tissues

Radiation effects on tissues, tissue cultures, organs, and unicellular organisms.

Radiation Effects Therapy and Countermeasures

Use of biological extracts, chemical compounds, or drugs to alter, prevent, simulate, or treat the effects of radiation on organisms or their components. The use of special shields to prevent radiation effects is included in the subcategory *Radiation Hazards and Protection* of this category.

Radiation Hazards and Protection

Measurement and hazards of radioactive material in the biosphere; studies of maximum permissible concentrations of radioactive materials on organisms or their components; and the use of rules, procedures, and equipment to reduce radiation exposure. Users of this subcategory should also see the subject category HEALTH AND SAFETY.

Radiotherapy and Radiodiagnosis

Use of both external and internal radiation sources in the diagnosis and therapy of disease. Also includes all phases of radiation equipment, procedure, and effectiveness.

CHEMISTRY

This category excludes *biochemistry*, which is found in the category BIOLOGY AND MEDICINE; *corrosion* which is a subcategory of METALS, CERAMICS, AND OTHER MATERIALS; and *geochemistry* which is included in the category GEOLOGY, METEOROLOGY, AND MINERALOGY.

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Analytical Procedures

Qualitative and quantitative procedures, radiochemical analysis, neutron-activation analysis, and mass spectroscopy.

Inorganic and Physical Chemistry

Chemistry of elements and inorganic compounds and chemical thermodynamics. Chemistry of elements and inorganic compounds is also included in the subcategories *Analytical Procedures*, *Radiation Chemistry*, *Radiochemistry*, and *Separation Processes and Procedures* of this category and in the category METALS, CERAMICS, AND OTHER MATERIALS. Radiation effects on chemical properties and reactions are included in the subcategory *Radiation Chemistry* of this category.

Organic Chemistry

Chemical and physical properties and reactions of organic compounds and systems of compounds. Equipment and procedures for investigating such properties and reactions are also included. For radiation effects on organic compounds, see the subcategory *Radiation Chemistry* of this category. Also see the subcategory *Separation Processes and Procedures* of this category.

Radiation Chemistry

Radiation effects on chemical properties and reactions, radiation effects on physical properties of nonmetallic elements and compounds and organic compounds. Also includes the generation of visible light as a result of radiation. Radiation effects on biological materials are included in the subcategories *Radiation Effects on Tissues* and *Radiation Effects on Biochemicals* of the category BIOLOGY AND MEDICINE. Radiation effects on metals and intermetallic compounds are included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Radiochemistry

Chemistry of radioactive materials and special chemical procedures and equipment required as a result of the presence of radiation. Also includes the preparation and calibration of isotopic sources of ionizing radiation. Neutron sources are included in the subcategory *Neutron Physics* in the category PHYSICS. See also the subcategory *Separation Processes and Procedures* of this category and the category WASTE DISPOSAL AND PROCESSING.

Separation Processes and Procedures

Chemistry and chemical engineering for processing uranium and thorium ores and reactor fuel and breeder materials. Also includes chemical separations not designed for analytical purposes or for isotopic separations of an element. Analytical separations are included in the subcategory *Analytical Procedures* of this category, and separations of isotopes of an element are included in the category ISOTOPE TECHNOLOGY.

ENGINEERING

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Applications of Nuclear Explosions

Engineering applications of nuclear explosions or simulated nuclear explosions.

Facilities and Equipment

Plants, plant facilities, and equipment not designed for specific application in one of the other categories.

Heat Transfer and Fluid Flow

Theoretical studies and engineering applications of heat transfer and fluid flow. For thermodynamics and magnetofluiddynamics, see the subcategory *Fluid Physics and Thermodynamics* of the category PHYSICS.

Materials Testing

Information primarily concerned with equipment, methods, and techniques for destructive or nondestructive testing. When the material is of primary interest, information on testing (including corrosion and erosion) is included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Protective Structures

Design, construction, and effectiveness of blast and fallout shelters and other protective structures.

Space Propulsion

Design, development, testing, and evaluation of electric, ion, nuclear, plasma jet, and other propulsion methods for space use.

Vacuum Engineering

Design and construction of vacuum systems and equipment (e.g., vacuum pumps). Excludes properties of materials under vacuum environment and vacuum systems and equipment that are more appropriately categorized according to the application (e.g., a vacuum system specifically intended for an accelerator is included in the subcategory *Accelerators* of the category PHYSICS).

GEOLOGY, METEOROLOGY, AND MINERALOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Meteorology

Atmospheric and weather conditions, climatology, general meteorological problems, and meteorological studies made for the purpose of obtaining information on the movement of air-borne particulate matter. Meteorology included in site-selection reports is included in the subcategory *Site Survey and Selection.*

Natural Radioactivity and Fallout

Ground levels and movement of radioactive materials, both natural and artificial, and elemental and isotopic compositions of minerals.

Site Survey and Selection

Reactor and plant site-selection studies.

Techniques and Equipment

The use of radiometric techniques and equipment in geology and mineralogy, e.g., age estimation and well logging techniques. Also seismology associated with nuclear-explosion detection.

Thorium and Uranium Minerals

Structures and properties of thorium and uranium minerals.

HEALTH AND SAFETY

Critical limits for moving and storing fissionable, radioactive, and toxic materials; experience in applied health physics; the development of, and experience with, personnel-protection procedures; and general industrial- and radiation-hazards analyses. Excludes studies performed to establish maximum allowable concentrations and limits of exposure, which are included in the subcategory *Radiation Hazards and Protection* of the category BIOLOGY AND MEDICINE.

INSTRUMENTATION

This category excludes the specific applications of an instrument. These are categorized by the subject of the application.

General

Design, testing, and use of instruments, except radiation detection, where these aspects of instrumentation are the main subjects.

Radiation Detection

Radiation-detection instruments and their components.

Radiation Effects

Effects of radiation on any instrument or instrument component.

ISOTOPE TECHNOLOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Industrial Applications

Applications to industrial processes and equipment for such applications. Applications to basic research are found under such categories as CHEMISTRY.

Power Application

Applications of radioisotopes in the production of electric or thermal energy or thrust.

Separation and Production

Separation of isotopes of one element in microquantities or macroquantities. Separation of isotopes of different elements is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.

MATHEMATICS AND COMPUTERS

Pure mathematics; statistics; and the design, development, and operation of computers. Information on applied mathematics and computer applications is categorized according to the application (e.g., computers used as simulators of various devices and pro-

cesses are categorized in the same manner as the device or process simulated; computer codes and applied mathematics are categorized on the basis of the application).

METALS, CERAMICS, AND OTHER MATERIALS

The term "other materials" refers to such substances as plastics, rubbers, other elastomers, wood, concrete, graphite, and petroleum.

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Corrosion

Corrosion and erosion studies that appear to be directed toward specific applications. Excludes studies primarily concerned with physical chemistry, reaction kinetics, etc., which are included in the category CHEMISTRY.

Fabrication

Fabrication methods, procedures, and equipment, including those for fuel elements and reactor components.

Properties and Structure

Mechanical, physical, and structural properties.

Radiation Effects

Effects of radiation on mechanical, physical, and structural properties. Chemical effects of radiation are included in the subcategory *Radiation Chemistry* of the category CHEMISTRY.

PHYSICS

General

Information which falls under the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Accelerators

Theory, design, development, construction, and operation of high voltage machines and particle accelerators and their components. Also experimental and theoretical studies of charged-particle beam motion in electric and magnetic fields pertinent to accelerator beam bending, stability, or transport.

Astrophysics and Cosmology

Origin and cosmic abundances of elements, isotopic composition and radiation exposure ages of meteorites, stellar processes, and stellar and interstellar magnetic fields.

Atomic Physics

Physical properties and theory of atoms and molecules and their interactions, reactions, and scattering. Also experimental and theoretical studies of mesic atoms and molecules and the production of atomic and molecular beams and mechanisms of atomic beam bombardment of materials.

Cosmic Radiation

Origin, intensity variations, acceleration processes, etc., of cosmic radiation. For the properties of specific cosmic particles or the use of cosmic radiation merely as a source of high-energy particles, see the subcategories *Elementary Particles and Radiations* and *Nuclear Properties and Reactions* of this category, depending on the emphasis.

Direct Energy Conversion

Equipment, techniques, and theory of direct-energy conversion, including magnetohydrodynamic cells and thermionic cells.

Elementary Particles and Radiations

Experimental and theoretical studies of the interactions and properties of particular particles or radiations. Also studies on positronium and muonium. Users should also see the subcategory *Field Theory, Scattering Theory, and Symmetries* of this category. The diffusion of particles and radiations in shielding materials and configurations is included in the subcategory *Shielding* of this category.

Field Theory, Scattering Theory, and Symmetries

General scattering theory and the applications of quantum field theory and group theory to the interactions or properties of elementary particles in general or to types of particles. For applications to particular particles, see the subcategory *Elementary Particles and Radiations* of this category.

Fluid Physics and Thermodynamics

The structure, properties, and dynamics of liquids and gases, electrodynamics, magnetohydrodynamics, and thermodynamics. Also phenomena of electric discharges and shock propagation in gases. Superfluidity is included in the subcategory *Low Temperature Physics* of this category. Users should also see the category *Plasma Physics and Thermonuclear Processes* of this category.

Geophysics

Geomagnetic phenomena and upper atmosphere physics, particle kinetics and geomagnetic trapping in radiation belts, and phenomena resulting from solar wind-geomagnetic field interactions.

Gravitation, Quantum Mechanics, and Relativity Theory

Theory on gravitational quanta and waves, quantum electrodynamics, and general and special relativity theory.

Low Temperature Physics

Cryogenics, superconductivity, and superfluidity. Applications are found under categories for the applications.

Neutron Physics

Experimental and mathematical treatments of neutron absorption, attenuation, moderation, multiplication, scattering, etc., in real and hypothetical media. Also the development and calibration of neutron generators and sources. Neutron physics studies conducted for a specified application are categorized according to the application (e.g., the category REACTOR TECHNOLOGY and the subcategory *Shielding* of this category). Neutron reactions with specific nuclei are included in the subcategory *Nuclear Properties and Reactions* of this category.

Nuclear Properties and Reactions

Experimental and theoretical studies relating to nuclear properties and reactions.

Plasma Physics and Thermonuclear Processes

Fundamental plasma experiments and theory and experimental and theoretical studies relating to controlled release of energy from thermonuclear reactions. Also the theory, design, and development of equipment for plasma and thermonuclear research. Electric discharge phenomena, electrodynamics, and magnetohydrodynamics are included in the subcategory *Fluid Physics and Thermodynamics* of this category.

Shielding

Theoretical and experimental studies relating to the diffusion, attenuation, absorption, and scattering of particles and radiations in shielding materials and configurations. For information on the fabrication of shielding materials and configurations, see the subcategory *Fabrication* of the category METALS, CERAMICS, AND OTHER MATERIALS.

Solid State Physics

Crystallography, the theory of the structure of metals, alloys, and ionic crystals, cohesive forces, band structure, thermal

vibration, intrinsic photoconductivity, plasticity, lattice defects, color centers, and dislocation theory. Users of this subcategory should also see the subcategory *Inorganic and Physical Chemistry* in the subject category CHEMISTRY and the subcategory *Properties and Structure* of the category METALS, CERAMICS, AND OTHER MATERIALS.

REACTOR TECHNOLOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Auxiliaries and Components

Design and construction of auxiliaries, components, control systems, and instrumentation not intended for a specific reactor.

Criticality Studies

Theoretical and experimental studies of neutron physics and parameters of unspecified reactors.

Design and Feasibility

Design and feasibility studies of reactor types not designated as power, process heat, production, propulsion, research, or test and not associated with a specific reactor.

Fuels

Design and theory of fuel elements not associated with a specific reactor. Studies of fuel-element materials are included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Power and Power-Breeder Reactors

Design, construction, feasibility, operation, and economics of specific reactors and classes of reactors. Also includes auxiliaries, components, and criticality studies for such reactors. Dual-purpose reactors are included in the subcategory *Process Heat Reactors* of this category.

Process Heat Reactors

Dual-purpose reactors and reactors designed to produce heat for uses other than the production of electricity or propulsion. Also includes auxiliaries, components, and criticality studies for such reactors.

Production Reactors

Design, construction, feasibility, economics, and operation of reactors devoted primarily to the production of fissionable materials or isotopes. Also includes auxiliaries, components, and criticality studies for such reactors.

Propulsion and Space

Design, construction, feasibility, economics, and operation of reactors for the propulsion of vehicles (land, water, air, and space). Also includes auxiliaries, components, and criticality studies for such reactors. The vehicles themselves are included only if the influence on the reactor is considered.

Research and Test Reactors

Design, construction, feasibility, economics, and operation of reactors used for radiation-effects studies and other basic research. Also includes auxiliaries, components, and criticality studies for such reactors.

WASTE DISPOSAL AND PROCESSING

Chemistry and chemical engineering for the storage, disposal, and control of radioactive waste materials, including the treatment of waste materials prior to disposal, such as concentration,

neutralization, filtration, or calcination. Safety aspects of radioactive waste handling and disposal are included in the category HEALTH AND SAFETY. Ecological aspects of waste materials are included in the subcategory *Ecology* of the category BIOLOGY AND MEDICINE. Some radiochemical aspects are included in the subcategory *Radiochemistry* of the category CHEMISTRY. Fuel-element processing is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.

GENERAL AND MISCELLANEOUS

This category, for the most part, contains abstracts of research and development reports of the U. S. Atomic Energy Commission and its contractors that are essentially nonnuclear in nature or are outside the scope of the other categories in *NSA*. Such abstracts have been included in *Research and Development Abstracts of the USAEC*. *RDA* was discontinued after issue number 8, Dec. 1963.

Additionally, both AEC and non-AEC originated broad summary type documents with diverse subject matter will be found under this category.

Appendix II

SUBJECT SCOPE OF NUCLEAR SCIENCE ABSTRACTS

Nuclear science is the study of the production, properties, principles, and phenomena of atomic nuclei, sub-atomic particles, and gamma and x radiation. Nuclear technology is the application of the principles and phenomena of nuclear science to the fields of science and engineering, and, conversely, the application of other science and engineering to the problems of nuclear science. These definitions, however, require further refinement to permit the user to determine exactly what *NSA* covers and also to permit uncontested selection or rejection of any piece of literature for *NSA*. Material selected for *NSA* is based solely on its subject content regardless of its form, origin, or language. The subject matter for *NSA* lies in 16 major subject fields, the limits of which are stated in the following scope notes. The specific interest in each of the elements is given in the second part of these notes.

Subject Fields of Interest

BIOLOGY AND MEDICINE

Ecological studies of radioactive materials

Metabolism, tissue distribution, and toxicology of all radioisotopes, of the actinides (including actinium), and of the fission-product elements strontium, iodine, barium, and cesium

Radiation-effects studies (particle, x ray, gamma ray, ultraviolet, and laser or maser beams) in all fields of biology, including second- and third-generation effects

Radiation hazards and protection

Radiation sickness

Radiotherapy and radiodiagnosis only if new equipment or techniques are used or if radiation side effects are discussed

Tracer studies if the isotope itself is the object of study or if the information on the tracer technique is new

CHEMISTRY

All chemistry of actual or simulated fission products and of actinides (including actinium)

Analysis, determination, and separation of lanthanides (including lanthanum)

Chemical methods for separating isotopes

Chemical stability of reactor moderators, fuels, coolants, control elements, and structures in storage or under accidental conditions, such as fire, flooding, or transport accidents

Chemistry involved in the preparation and use of radiation targets

Chemistry of compounds of noble or inert gases, including preparation or attempted preparation

Chemistry of radioactive waste processing, storage, and disposal

Chemistry of reactor coolants, moderators, and fuels
Corrosion and erosion in reactor fuel processing and waste disposal
Corrosion and erosion under actual or simulated reactor conditions
Isotope effects on chemical properties and reactions
Isotopic labeling of chemical compounds
Laboratory techniques for studying and processing thorium and uranium minerals
Radiation chemistry, radiochemistry, and radioanalytical techniques and equipment
Radioactive decontamination
Separation chemistry of reactor fuels and breeding blankets

ENGINEERING

Control engineering and automated systems applied to nuclear facilities, plants, or laboratories
Design and construction of laboratories, pilot plants, plant facilities, and equipment for handling and processing radioactive materials, reactor fuel and blanket materials, or feed materials (beginning with UO_3)
Design and construction of structures for protection against the effects of nuclear explosions
Engineering applications of, and seismological studies associated with, nuclear or simulated nuclear explosions
Heat-transfer and fluid-flow studies applied to nuclear facilities, plants, or laboratories
Magnetofluiddynamic flow
Materials testing limited to applications in nuclear technology or to new techniques involving nuclear phenomena
Ultrahigh vacuum engineering, i.e., 10^{-9} torr or greater, and other vacuum engineering as applied to accelerators or to thermonuclear devices

GEOLOGY AND MINERALOGY

Engineering applications of nuclear or simulated nuclear explosions
Geology studies for the selection of reactor, weapons-test, and waste-disposal sites
Hydrological studies involving movement of radioactive waste and fallout
Identification and description of new thorium and uranium minerals
Laboratory techniques for studying and processing thorium and uranium minerals
New radiometric techniques and equipment, including those used for geological-age determination and well logging
Seismology associated with nuclear or simulated nuclear explosions or with site selection
Studies of natural radioactivity

HEALTH AND SAFETY

All factors concerned with radiation incidents or with accidents involving radioactive or fissionable materials, including decontamination
Maximum permissible concentrations of radioactive materials
Protective measures and equipment, safety procedures, and criticality and hazards studies associated with reactors or radiations
Radiation-dosage determinations, limits, and standards
Safety regulations and limits for handling, processing, storing, and transporting fissionable and radioactive materials

INSTRUMENTATION

Design, development, construction, testing, theory, and evaluation of radiation-detection instruments and systems
Instrumentation, in addition to that for radiation detection, only if directly applied in nuclear technology
Radiation effects on instruments and components

ISOTOPE TECHNOLOGY

Isotope effects on the physical and chemical properties of matter
Methods for labeling compounds
Preparing, handling, and storing radiation sources and radioisotopes
Production and separation of isotopes (stable and radioactive)
Tracer studies only if the isotope itself is the object of study or if the information on the tracer technique is new
Use of isotopes or fission products as radiation sources or power sources except in routine applications (e.g., routine laboratory, industrial, and medical uses)

MATHEMATICS AND COMPUTERS

Applications of computers, codes, and mathematics to the solution of nuclear-science problems

METALLURGY AND CERAMICS

Corrosion and erosion in reactor fuel processing and waste disposal
Corrosion and erosion under actual or simulated reactor conditions
Metallurgical studies on elements and their alloys and systems for reactor, accelerator, or other nuclear applications
Metallurgy of the actinides, the lanthanides, and the elements beryllium, molybdenum, niobium, rhenium, tantalum, technetium, tungsten, yttrium, and zirconium, including the metallurgy of their alloys, compounds, and systems
Radiation effects on materials
Studies on ceramics, refractories, and cermets for reactor, accelerator, or other nuclear applications

METEOROLOGY

Meteorological studies for the selection of reactor and explosion test sites
Radioactive aerosol and gas production, dispersal, precipitation, agglomeration, and stack disposal
Radioactive fallout
Radioactivity in the atmosphere

NUCLEAR EXPLOSIONS

All scientific and technical aspects of actual or simulated nuclear explosions

PHYSICS

Accelerators (not including propulsion devices)
  All scientific and technical aspects, including the ion source
Astrophysics
  Cosmic origin and abundance of elements and isotopes
  Gravitational collapse
  Other solar and stellar phenomena only when nuclear reactions, particle kinetics, plasma, or magnetofluiddynamics are involved
Cosmic Radiation
  All scientific and technical aspects
Cryogenics
  As applied to nuclear science
  Involving nuclear phenomena or techniques
Direct Energy Conversion
  Any study involving nuclear phenomena or techniques
  Other studies limited to magnetofluiddynamic, plasma, and thermionic devices and applications of thermoelectric devices to reactor or other nuclear facilities
Field Theory and Quantum Electrodynamics
Geophysics
  Auroral or ionospheric phenomena only when particle kinetics are discussed
  High-altitude nuclear detonations and effects
  Particle kinetics and geomagnetic trapping in radiation belts
  Particle phenomena resulting from solar-storm interactions with the earth's magnetic field
  Seismic studies for the detection of nuclear explosions
Nuclear Physics
  Absorption, interaction, and scattering of gamma and x radiation
  Acceleration and nuclear reactions of ions, e.g., C^{14} ions
  All properties, reactions, and phenomena associated with the nucleus, either experimental or theoretical
  All scientific and technical aspects of elementary particles
  Electron-paramagnetic-resonance and nuclear-magnetic-resonance studies when the technique is the object of study
  Mössbauer-effect studies when the technique is the object of study
Plasma Physics
  Effects of electric or magnetic fields on plasma oscillations and particle dynamics
  Electromagnetic radiation emitted by ionized gases, e.g., cyclotron radiation
  Magnetofluiddynamics
  Motions and reactions of particles in electric and magnetic fields, excluding electron-tube and arc phenomena
  Production, properties, containment, and heating of plasma, excluding electron-tube plasma and routine applications of arc plasma
  Shock-produced plasma, excluding atmospheric re-entry and exploding-wire phenomena
  Theory, design, development, and experimen-

tation (including ionization studies) relating to controlled fusion

Shielding
- All aspects of shielding against ionizing radiation, neutrons, and accelerated particles
- Thermal shielding for reactors and for protection against nuclear explosions

Solid-State Physics
- Limited to radiation effects, radiation detectors, and nuclear and reactor applications

Superconductivity
- All scientific and technical aspects

Vacuum Technology
- Ultrahigh vacuum (10^{-9} torr or greater)
- Vacuum-technology applications to accelerators or to thermonuclear devices

RADIATION EFFECTS

All effects of particles (including ions) or of x or gamma radiation

Only biological effects of ultraviolet radiation and laser or maser beams

Thermal-radiation effects only if associated with nuclear explosions

RADIATION-RESISTANT MATERIALS

All scientific and technical aspects

REACTOR TECHNOLOGY

All scientific, technical, and economic aspects of nuclear fission and fusion reactors, including feasibility studies and site selection

Design, development, and testing of nuclear power plants and of components modified because of the reactor

Reactor theory, including neutron physics, criticality studies, reactor criticality effects of any element, and reactor control

WASTE DISPOSAL AND PROCESSING

All scientific and technical information dealing with radioactive waste

Extent of Interest in the Elements

ACTINIUM
- All scientific and technical aspects

ALUMINUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

AMERICIUM
- All scientific and technical aspects

ANTIMONY
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

ARGON
- Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

ARSENIC
- Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ASTATINE
All scientific and technical aspects

BARIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BERKELIUM
All scientific and technical aspects

BERYLLIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BISMUTH
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BORON
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BROMINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CADMIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CALCIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CALIFORNIUM
All scientific and technical aspects

CARBON
Applications of the element or its compounds or systems in nuclear technology or the

behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Properties and fabrication of nuclear-grade graphite and graphite fuel materials
Radiation effects
Radiochemistry

CERIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CESIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CHLORINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine application as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CHROMIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

COBALT
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

COPPER
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CURIUM
All scientific and technical aspects

DYSPROSIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes

Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

EINSTEINIUM
All scientific and technical aspects

ERBIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

EUROPIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

FERMIUM
All scientific and technical aspects

FLUORINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

FRANCIUM
All scientific and technical aspects

GADOLINIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GALLIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GERMANIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GOLD
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HAFNIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HELIUM
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HOLMIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HYDROGEN
Applications of the element or its compounds and systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of deuterium and tritium
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

INDIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IODINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IRIDIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IRON
Applications of the element and its alloys or systems, including steel and stainless steel, in nuclear technology or the behavior of the element, its alloys, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

KRYPTON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Chemistry of any compounds (e.g., KrF_2 or KrF_4), including preparation or attempted preparation
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LANTHANUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LAWRENCIUM (103)
All scientific and technical information

LEAD
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LITHIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LUTETIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MAGNESIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MANGANESE
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions

Radiation effects
Radiochemistry

MENDELEVIUM
All scientific and technical aspects

MERCURY
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MOLYBDENUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEODYMIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEPTUNIUM
All scientific and technical aspects

NICKEL
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NIOBIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NITROGEN
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NOBELIUM
All scientific and technical aspects

OSMIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

OXYGEN
- Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PALLADIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PHOSPHORUS
- Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PLATINUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PLUTONIUM
- All scientific and technical aspects

POLONIUM
- All scientific and technical aspects

POTASSIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PRASEODYMIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PROMETHIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

PROTACTINIUM
All scientific and technical aspects

RADIUM
All scientific and technical aspects

RADON
All scientific and technical aspects

RHENIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RHODIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RUBIDIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RUTHENIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SAMARIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SCANDIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SELENIUM
Applications of the element or its compounds or systems in nuclear technology or the

behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SILICON
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SILVER
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SODIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

STRONTIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SULFUR
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TANTALUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TECHNETIUM
All scientific and technical aspects

TELLURIUM
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TERBIUM
Analysis, determination, and separation

Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Radiation effects
Radiochemistry

THALLIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

THORIUM
All scientific and technical aspects except exploration, mining, ore processing, and routine industrial uses, e.g., thoriated cathodes

THULIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TIN
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TITANIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TUNGSTEN
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

URANIUM
All scientific and technical aspects except exploration, mining, ore processing, and routine industrial applications

VANADIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

XENON
- Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
- Chemistry of any compounds (e.g., XeF_4, XeF_6, or XeO_3), including preparation or attempted preparation
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

YTTERBIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

YTTRIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

ZINC
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

ZIRCONIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

Appendix III

JOURNAL LIST

This is a list of journals and their abbreviations arranged alphabetically by the abbreviation used in *NSA*. Titles marked by an asterisk (*) are those that are scanned regularly. Titles without asterisks are journals from which some abstracts were taken during Volume 19, although these journals are not scanned regularly.

The Russian journals identified by a dagger (†) are available commercially in complete English translation.

Cross references have been included for some non-English language titles as well as for variant forms of titles used in this list. For journals on the present scanning list that fall in either of these categories, the asterisk appears only with the form of the title used for *NSA*. Some journals which have undergone name changes in recent years have been so identified parenthetically after the title. The original language title for a translated journal is given in parentheses after the English title.

Abhandl. Deut. Akad. Wiss. Berlin, Kl. Chem., Geol. Biol.
Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fuer Chemie, Geologie und Biologie *(Germany)*

Abhandl. Deut. Akad. Wiss. Berlin, Kl. Med.
Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fuer Medizin *(Germany)*

ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo)
ABM (Boletim da Associacao Brasileira de Metais) (Sao Paulo) *(Brazil)*

Abstr. Bulgar. Sci. Lit., Math., Phys., Astron., Geophys., Geodesy
*Abstracts of Bulgarian Scientific Literature, Mathematics, Physics, Astronomy, Geophysics, Geodesy *(Bulgaria)*

Abstr. Japan. Sci. Tech. Periodicals
*Abstracts of Articles Published in Japanese Scientific and Technical Periodicals *(U. S.)*

Acad. Rep. Populare Romine, Baza Cercetari Stiint. Timisoara, Studii Cercetari, Stiinte Chim.
Academia Republicii Populare Romine, Baza de Cercetari Stiintifice Timisoara, Studii si Cercetari, Stiinte Chimice *(Romania)*

Acad. Rep. Populare Romine, Filiala Cluj, Studii Cercetari Med.
Academia Republicii Populare Romine, Filiala Cluj, Studii si Cercetari de Medicina *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Biochim.
Academia Republicii Populare Romine, Institutul de Biochemie, Studii si Cercetari de Biochimie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Chim.
Academia Republicii Populare Romine, Studii si Cercetari de Chimie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Endocrinol.
Academia Republicii Populare Romine, Institutul de Endocrinologie "Prof. C. I. Parhon," Studii si Cercetari de Endocrinologie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Fiz.
Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Fiziol.
Academia Republicii Populare Romine, Institutul de Fiziologie Normala si Patologica "Dr. D. Danielopolu," Studii si Cercetari de Fiziologie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Inframicrobiol.
Academia Republicii Populare Romine, Institutul de Inframicrobiologie, Studii si Cercetari de Inframicrobiologie *(Romania)*

Acta Agral. Fennica
Acta Agralia Fennica *(Finland)*

Acta Allergol.
Acta Allergologica *(Denmark)*

Acta Anat.
*Acta Anatomica *(Switzerland)*

Acta Astron. Sinica
Acta Astronomica Sinica
see Tien Wen Hsueh Pao

Acta Biochim. Biophys. Sinica
Acta Biochimica et Biophysica Sinica
see Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao

Acta Biochim. Polon.
Acta Biochimica Polonica *(Poland)*

Acta Biochim. Polon. (English Transl.)
*Acta Biochimica Polonica (English Translation) *(Poland)*

Acta Biol. Cracov., Ser. Zool.
Acta Biologica Cracoviensia, Serie Zoologie *(Poland)*

Acta Biol. Exptl. Sinica
Acta Biologiae Experimentalis Sinica
see Shih Yan Sheng Wu Hsueh Pao

Acta Biol. Med. Ger.
Acta Biologica et Medica Germanica *(Germany)*

Acta Botan. Sinica
Acta Botanica Sinica
see Chih Wu Hsueh Pao

Acta Chem. Scand.
*Acta Chemica Scandinavica *(Denmark)*

Acta Chim. Acad. Sci. Hung.
*Acta Chimica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chim. Sinica
Acta Chemica Sinica
see Hua Hsueh Hsueh Pao

Acta Chir. Acad. Sci. Hung.
Acta Chirurgica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chir. Belg.
Acta Chirurgica Belgica *(Belgium)*

Acta Cient. Venezolana
*Acta Cientifica Venezolana *(Venezuela)*

Acta Cryst.
*Acta Crystallographica *(Denmark)*

Acta Cytol.
*Acta Cytologica *(U. S.)*

Acta Endocrinol.
Acta Endocrinologica *(Denmark)*

Acta Entomol. Sinica
Acta Entomologica Sinica
see K'un Ch'ung Hsueh Pao

Acta Fac. Rerum Nat. Univ. Comenianae, Botan.
Acta Facultatis Rerum Naturalium Universitatis Comenianae, Botanica *(Czechoslovakia)*

Acta Geophys. Polon.
*Acta Geophysica Polonica *(Poland)*

Acta Geophys. Sinica
Acta Geophysica Sinica
see Ti Ch'iu Wu Li Hsueh Pao

Acta Gerontol.
*Acta Gerontologica *(Italy)*

Acta Ginecol.
Acta Ginecologica *(Spain)*
Acta Gynaecol. Obstet. Hispano Lusitana
*Acta Gynaecologica et Obstetrica Hispano Lusitana *(Portugal)*
Acta Haematol.
Acta Haematologica *(Switzerland)*
Acta Haematol. Japon.
Acta Haematologica Japonica
see Nippon Ketsueki Gakkai Zasshi
Acta Hepato-Splenol.
Acta Hepato-Splenologica *(Germany)*
Acta Histochem.
*Acta Histochemica *(Germany)*
Acta Iberica Radiol.-Cancerol.
Acta Iberica Radiologica-Cancerologica *(Spain)*
Acta IMEKO
*Acta IMEKO *(Hungary)*
Acta Isotopica
*Acta Isotopica *(Italy)*
Acta Med. Acad. Sci. Hung.
Acta Medica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Med. Hidalguense
*Acta Medica Hidalguense *(Mexico)*
Acta Med. Iranica
*Acta Medica Iranica *(Iran)*
Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*
Acta Med. Okayama
*Acta Medicinae Okayama *(Japan)*
Acta Med. Polona
*Acta Medica Polona *(Poland)*
Acta Med. Scand.
Acta Medica Scandinavica *(Sweden)*
Acta Met.
*Acta Metallurgica *(U. S.)*
Acta Met. Sinica
Acta Metallurgica Sinica
see Chin Shu Hsueh Pao
Acta Microbiol. Acad. Sci. Hung.
Acta Microbiologica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Microbiol. Polon.
*Acta Microbiologica Polonica *(Poland)*
Acta Morphol. Acad. Sci. Hung.
Acta Morphologica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Morphol. Neerl.-Scand.
*Acta Morphological Neerlando-Scandinavica *(Netherlands)*
Acta Neurochir.
Acta Neurochirurgica *(Austria)*
Acta Neurol. Latinoam.
*Acta Neurologia Latinoamericana *(Uruguay)*
Acta Neuropsiquiat. Arg.
*Acta Neuropsiquiatrica Argentina *(Argentina)*
Acta Odontol. Scand.
Acta Odontologica Scandinavica *(Sweden)*
Acta Oncol.
Acta Oncologica *(Spain)*
Acta Ophthalmol.
Acta Ophthalmologica *(Denmark)*
Acta Paediat.
*Acta Paediatrica *(Sweden)*
Acta Pathol. Japon.
*Acta Pathologica Japonica *(Japan)*
Acta Pathol. Microbiol. Scand.
Acta Pathologica et Microbiologica Scandinavica *(Denmark)*
Acta Pharm. Sinica
Acta Pharmaceutica Sinica
see Yao Hsueh Hsueh Pao
Acta Phys. Acad. Sci. Hung.
*Acta Physica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Phys. Austriaca
*Acta Physica Austriaca *(Austria)*
Acta Phys. Austriaca, Suppl.
*Acta Physica Austriaca, Supplementum *(Austria)*
Acta Physiol. Acad. Sci. Hung.
Acta Physiologica Academiae Scientiarum Hungaricae *(Hungary)*
Acta Physiol. Latinoam.
Acta Physiologica Latinoamericana *(Argentina)*
Acta Physiol. Polon.
*Acta Physiologica Polonica *(Poland)*
Acta Physiol. Scand.
Acta Physiologica Scandinavica *(Sweden)*
Acta Phys. Polon.
*Acta Physica Polonica *(Poland)*
Acta Phys. Sinica
Acta Physica Sinica
see Wu Li Hsueh Pao
Acta Polytech. Scand., Phys. Nucl. Ser.
Acta Polytechnica Scandinavica, Physics including Nucleonics Series *(Sweden)*
Acta Protozool. (Warsaw)
Acta Protozoologica (Warsaw) *(Poland)*
Acta Radiol., Suppl.
*Acta Radiologica, Supplementum *(Sweden)*
Acta Radiol. Therapy, Phys., Biol.
*Acta Radiologica. Therapy, Physics, Biology *(Sweden)*
Acta Rheumatol. Scand.
*Acta Rheumatologica Scandinavica *(Sweden)*
Acta Schol. Med. Gifu
Acta Scholae Medicinalis in Gifu
see Gifu Ika Daigaku Kiyo
Acta Schol. Med., Univ. Kioto
Acta Scholae Medicinalis, Universitatis in Kioto *(Japan)*
Actas Dermo-Sifilog.
*Actas Dermo-Sifilograficas *(Spain)*
Acta Soc. Med. Upsalien.
*Acta Societatis Medicorum Upsaliensis *(Sweden)*
Acta Soc. Ophthalmol. Japon.
Acta Societatis Ophthalmologicae Japonicae
see Nippon Ganka Gakkai Zasshi
Acta Tech. CSAV
Acta Technica CSAV (Ceskoslovenska Akademia Ved) (formerly Acta Technica (Prague)) *(Czechoslovakia)*
Acta Tuberc. Scand.
Acta Tuberculosea Scandinavica *(Denmark)*
Acta Unio Intern. Contra Cancrum
Acta Unio Internationalis Contra Cancrum *(Belgium)*
Acta Univ. Carolinae, Med., Suppl.
Acta Universitatis Carolinae, Medica, Supplementum *(Czechoslovakia)*
Acta Univ. Debrecen. Ludovico Kossuth Nom., Ser. Phys. Chim.
Acta Universitatis Debreceniensis de Ludovico Kossuth Nominatae, Series Physica et Chimica *(Hungary)*
Acta Univ. Lund., Sect. II
Acta Universitatis Lundensis, Sectio II *(Sweden)*
Acta Univ. Palackianae Olomuc.
Acta Universitatis Palackianae Olomucensis *(Czechoslovakia)*
Acta Vet. Acad. Sci. Hung.
Acta Veterinaria Academiae Scientiarum Hungaricae *(Hungary)*
Acta Vet. Scand.
Acta Veterinaria Scandinavica *(Denmark)*
Acta Virol. (Prague)
*Acta Virologica (Prague) *(Czechoslovakia)*
Acta Zool. Sinica
Acta Zoological Sinica
see Tung Wu Hsueh Pao
Actualites Pharmacol.
Actualites Pharmacologiques *(France)*
Acustica
Acustica *(Germany)*
Adhesion Adhesives (Kyoto)
Adhesion and Adhesives (Kyoto)
see Setchaku
Advan. Anal. Chem. Instr.
*Advances in Analytical Chemistry and Instrumentation *(U. S.)*
Advan. Appl. Microbiol.
*Advances in Applied Microbiology *(U. S.)*
Advan. At. Mol. Phys.
*Advances in Atomic and Molecular Physics *(U. S.)*
Advan. Botan. Res.
Advances in Botanical Research *(U. S.–England)*
Advan. Cancer Res.
*Advances in Cancer Research *(U. S.)*
Advan. Chem. Eng.
*Advances in Chemical Engineering *(U. S.)*
Advan. Chem. Ser.
*Advances in Chemistry Series *(U. S.)*
Advan. Comp. Physiol. Biochem.
*Advances in Comparative Physiology and Biochemistry *(U. S.)*
Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*

Advan. Electron. Electron Phys.
*Advances in Electronics and Electron Physics *(U. S.)*
Advan. Energy Conversion
*Advanced Energy Conversion *(England)*
Advan. Fluorine Chem.
*Advances in Fluorine Chemistry *(U. S.)*
Advan. Food Res.
*Advances in Food Research *(U. S.)*
Advan. Genet.
*Advances in Genetics *(U. S.)*
Advan. Geophys.
*Advances in Geophysics *(U. S.)*
Advan. Gerontol. Res.
Advances in Gerontological Research *(U. S.)*
Advan. Heat Transfer
*Advances in Heat Transfer *(U. S.)*
Advan. Heterocyclic Chem.
*Advances in Heterocyclic Chemistry *(U. S.)*
Advan. Nucl. Sci. Technol.
*Advances in Nuclear Science and Technology *(U. S.)*
Advan. Obstet. Gynaecol.
Advances in Obstetrics and Gynaecology
see **Sanfujinka no Shimpo**
Advan. Organometal. Chem.
*Advances in Organometallic Chemistry *(U. S.)*
Advan. Org. Chem.
*Advances in Organic Chemistry: Methods and Results *(U. S.)*
Advan. Pest Control Res.
Advances in Pest Control Research *(U. S.)*
Advan. Photochem.
*Advances in Photochemistry *(U. S.)*
Advan. Phys.
*Advances in Physics *(England)*
Advan. Phys. Org. Chem.
*Advances in Physical Organic Chemistry *(U. S.)*
Advan. Radiation Biol.
*Advances in Radiation Biology *(U. S.)*
Advan. Sci.
Advancement of Science, The *(England)*
Advan. Spectry.
*Advance in Spectroscopy *(U. S.)*
Advan. Struct. Res. Diffraction Methods
*Advances in Structure Research by Diffraction Methods *(U. S.—Germany)*
Advan. Tracer Methodol.
*Advances in Tracer Methodology *(U. S.)*
Advan. Waste Treat. Res.
*Advances in Waste Treatment Research *(U. S.)*
Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*
A E G Mitt.
*A E G Mitteilungen *(Germany)*
AEI (Assoc. Elec. Ind.) Eng.
*AEI (Associated Electrical Industries) Engineering *(England)*
Aerospace Med.
*Aerospace Medicine (formerly The Journal of Aviation Medicine) *(U. S.)*
Aerztl. Forsch.
Aerztliche Forschung *(Germany)*
Afrique Franc. Chir.
*Afrique Francaise Chirurgicale *(Algeria)*
Aggiorn. Mal. Infezione
*Aggiornamenti sulle Malattie da Infezione *(Italy)*
Agr. Biol. Chem. (Tokyo)
*Agricultural and Biological Chemistry (Tokyo) *(Japan)*
Agr. Eng.
Agricultural Engineering *(U. S.)*
Agressologie
Agressologie *(France)*
Agri Hort. Genet.
Agri Hortique Genetica *(Sweden)*
Agr. Ital. (Pisa)
Agricoltura Italiana, L' (Pisa) *(Italy)*
Agrobiologiya
Agrobiologiya *(U.S.S.R.)*
Agrokhimiya
Agrokhimiya *(U.S.S.R.)*
Agron. J.
Agronomy Journal *(U. S.)*
Agron. Lusitana
*Agronomia Lusitana *(Portugal)*

AIAA (Am. Inst. Aeron. Astronaut.) J.
*AIAA (American Institute of Aeronautics and Astronautics) Journal (combining the ARS Journal and the Journal of Aerospace Sciences) *(U. S.)*
A.I.Ch.E. (Am. Inst. Chem. Engrs.) J.
*A.I.Ch.E. (American Institute of Chemical Engineers) Journal *(U. S.)*
Air Conditioning, Heating, Ventilating
Air Conditioning, Heating and Ventilating *(U. S.)*
Air Eng.
Air Engineering *(U. S.)*
Akad. Nauk Ukr. RSR, Inst. Teploenerg., Zb. Prats
*Akademiya Nauk Ukrain'skoi RSR, Institut Teploenergetiki, Zbirnik Prats *(Ukrainian S.S.R.)*
Akad. Wiss. Lit. (Mainz), Abhand. Math.-Nat. Kl.
Akademie der Wissenschaften und der Literatur (Mainz), Abhandlungen der Mathematisch-Naturwissenschaftlichen Klasse *(Germany)*
Alabama J. Med. Sci.
Alabama Journal of Medical Sciences, The *(U. S.)*
Alberta Med. Bull.
Alberta Medical Bulletin *(Canada)*
Alexandria Med. J.
*Alexandria Medical Journal, The *(Egypt)*
Algerie Med.
*Algerie Medicale *(Algeria)*
Allison Res. Eng.
*Allison Research and Engineering *(U. S.)*
Alluminio
Alluminio *(Italy)*
Alta Freq.
Alta Frequenza; Rivista di Radiotecnica, Telefonia e Acustica Applicata *(Italy)*
Aluminium
Aluminium *(Germany)*
Am. Ceram. Soc. Bull.
*American Ceramic Society Bulletin, The *(U. S.)*
Am. Heart J.
American Heart Journal *(U. S.)*
Am. Ind. Hyg. Assoc. J.
*American Industrial Hygiene Association Journal *(U. S.)*
Am. J. Anat.
American Journal of Anatomy, The *(U. S.)*
Am. J. Botany
*American Journal of Botany *(U. S.)*
Am. J. Clin. Pathol.
*American Journal of Clinical Pathology *(U. S.)*
Am. J. Digest. Diseases
American Journal of Digestive Diseases, The *(U. S.)*
Am. J. Diseases Children
American Journal of Diseases of Children *(U. S.)*
Am. J. Epidemiol.
American Journal of Epidemiology (formerly American Journal of Hygiene) *(U. S.)*
Am. J. Gastroenterol.
American Journal of Gastroenterology, The *(U. S.)*
Am. J. Human Genet.
*American Journal of Human Genetics, The *(U. S.)*
Am. J. Hyg.
American Journal of Hygiene *(U. S.)*
Am. J. Med. Electron.
American Journal of Medical Electronics *(U. S.)*
Am. J. Nursing
American Journal of Nursing, The *(U. S.)*
Am. J. Obstet. Gynecol.
American Journal of Obstetrics and Gynecology *(U. S.)*
Am. J. Ophthalmol.
American Journal of Ophthalmology *(U. S.)*
Am. J. Orthoped.
American Journal of Orthopedics, The *(U. S.)*
Am. J. Pathol.
*American Journal of Pathology, The *(U. S.)*
Am. J. Phys.
*American Journal of Physics *(U. S.)*
Am. J. Phys. Anthropol.
American Journal of Physical Anthropology *(U. S.)*
Am. J. Physiol.
*American Journal of Physiology, The *(U. S.)*
Am. J. Public Health
American Journal of Public Health and The Nation's Health *(U. S.)*

Am. J. Roentgenol., Radium Therapy Nucl. Med.
*American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, The *(U. S.)*

Am. J. Surg.
American Journal of Surgery, The *(U. S.)*

Am. J. Trop. Med. Hyg.
American Journal of Tropical Medicine and Hygiene *(U. S.)*

Am. J. Vet. Res.
American Journal of Veterinary Research *(U. S.)*

Am. Machinist/Metalworking Manuf.
American Machinist/Metalworking Manufacturing *(U. S.)*

Am. Mineralogist
*American Mineralogist, The *(U. S.)*

Am. Naturalist
*American Naturalist *(U. S.)*

Am. Rev. Respirat. Diseases
American Review of Respiratory Diseases *(U. S.)*

Am. Scientist
American Scientist (formerly The Sigma Xi Quarterly) *(U. S.)*

Am. Soc. Metals, Trans. Quart.
*American Society for Metals, Transactions Quarterly *(U. S.)*

Am. Soc. Testing Mater., Proc.
American Society for Testing and Materials, Proceedings, Committee Reports, Technical Papers *(U. S.)*

Am. Soc. Testing Mater., Spec. Tech. Publ.
American Society for Testing and Materials, Special Technical Publication *(U. S.)*

Am. Surgeon
American Surgeon *(U. S.)*

Am. Zoologist
American Zoologist *(U. S.)*

Anais Acad. Brasil. Cienc.
*Anais da Academia Brasileira de Ciencias *(Brazil)*

Anais Brasil. Dermatol. Sifilog.
*Anais Brasileiros de Dermatologia e Sifilografia *(Brazil)*

Anais Brasil. Ginecol. (Rio de Janeiro)
*Anais Brasileiros de Ginecologia (Rio de Janeiro) *(Brazil)*

Anais Inst. Med. Trop. (Lisbon)
*Anais Instituto de Medicina Tropical (Lisbon) *(Portugal)*

Anal. Abstr.
*Analytical Abstracts *(England)*

Anal. Biochem.
*Analytical Biochemistry *(U. S.)*

Anal. Chem.
*Analytical Chemistry *(U. S.)*

Anal. Chim. Acta
*Analytica Chimica Acta *(Netherlands)*

Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I
*Analele Stiintifice ale Universitatii "A. I. Cuza," din Iasi, Sectiunea I *(Romania)*

Analele Univ. Bucuresti, Ser. Stiint. Nat.
Analele Universitatii Bucuresti, Seria Stiintele Naturii (formerly Analele Universitatii "C. I. Parhon" Bucuresti, Seria Stiintelor Naturii) *(Romania)*

Analele Univ. "C. I. Parhon," Ser. Stiint. Nat.
Analele Universitatii "C. I. Parhon," Seria Stiintele Naturii (formerly Analele Universitatii "C. I. Parhon" Bucuresti, Seria Stiintelor Naturii) *(Romania)*

Anales Hosp. Militar Central (Lima, Peru)
*Anales del Hospital Militar Central (Lima, Peru) *(Peru)*

Anales Inst. Corachan (Barcelona)
*Anales del Instituto Corachan (Barcelona) *(Spain)*

Anales Inst. Geofis. UNAM, Mex.
Anales del Instituto de Geofisica UNAM, Mexico *(Mexico)*

Anales Inst. Oncol. "Angel H. Roffo"
*Anales del Instituto de Oncologia "Angel H. Roffo" *(Argentina)*

Anales Med. Cir.
*Anales de Medicina y Cirugia *(Spain)*

Anales Real Acad. Nacl. Med. (Madrid)
*Anales de la Real Academia Nacional de Medicina (Madrid) *(Spain)*

Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie A *(Spain)*

Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie B *(Spain)*

Anales Soc. Cient. Arg.
*Anales de la Sociedad Cientifica Argentina *(Argentina)*

Analyst
*Analyst, The *(England)*

Anat. Record
Anatomical Record, The *(U. S.)*

Anesthesiology
Anesthesiology *(U. S.)*

Angew. Chem.
Angewandte Chemie *(Germany)*

Angew. Chem. Intern. Ed. Engl.
*Angewandte Chemie. International Edition in English *(U. S.–Germany)*

Angiologia (Barcelona)
*Angiologia (Barcelona) *(Spain)*

Angiology
Angiology *(U. S.)*

Ann. Acad. Med. Lodz.
Annales Academiae Medicae Lodzensis *(Poland)*

Ann. Allergy
*Annals of Allergy *(U. S.)*

Ann. Acad. Sci. Fennicae, Ser. A V
Annales Academiae Scientiarum Fennicae, Series A V *(Finland)*

Ann. Acad. Sci. Fennicae, Ser. A VI
*Annales Academiae Scientiarum Fennicae, Series A VI. Physica *(Finland)*

Ann. Agr. Fenniae
Annales Agriculturae Fenniae *(Finland)*

Ann. Anat. Pathol.
*Annales d'Anatomie Pathologique *(France)*

Ann. Astrophys.
*Annales d'Astrophysique *(France)*

Ann. Biochem. Exptl. Med. (Calcutta)
*Annals of Biochemistry and Experimental Medicine (Calcutta) *(India)*

Ann. Biol. Clin. (Paris)
Annales de Biologie Clinique (Paris) *(France)*

Ann. Botany (London)
Annals of Botany (London) *(England)*

Ann. Chem.
Annalen der Chemie, Justus Liebigs *(Germany)*

Ann. Chim. (Paris)
Annales de Chimie (Paris) *(France)*

Ann. Chim. (Rome)
Annali di Chimica (Rome) *(Italy)*

Ann. Chir. Gynaecol. Fenniae
*Annales Chirurgiae et Gynaecologiae Fenniae *(Finland)*

Ann. Chir. Semaine Hop.
Annales de Chirurgie, La Semaine des Hopitaux *(France)*

Annee Biol.
Annee Biologique, L' *(France)*

Ann. Endocrinol. (Paris)
Annales d'Endocrinologie (Paris) *(France)*

Ann. Entomol. Soc. Am.
Annals of the Entomological Society of America *(U. S.)*

Ann. Gembloux
Annales de Gembloux *(Belgium)*

Ann. Genet.
Annales de Genetique *(France)*

Ann. Geophys.
Annales de Geophysique *(France)*

Ann. Histochim.
Annales d'Histochimie *(France)*

Ann. Inst. Henri Poincare
Annales de l'Institut Henri Poincare *(France)*

Ann. Inst. Henri Poincare, Sect. A
*Annales de l'Institut Henri Poincare, Section A. Physique Theorique *(France)*

Ann. Inst. Henri Poincare, Sect. B
*Annales de l'Institut Henri Poincare, Section B. Calcul des Probilities et Statistique *(France)*

Ann. Inst. Pasteur
Annales de l'Institut Pasteur *(France)*

Ann. Internal Med.
Annals of Internal Medicine *(U. S.)*

Ann. Intern. Geophys. Yr.
*Annals of the International Geophysical Year *(England)*

Ann. Ital. Chir.
Annali Italiani di Chirurgia *(Italy)*

Ann. Math. Statist.
Annals of Mathematical Statistics, The *(U. S.)*

Ann. Med. Exptl. Biol. Fenniae (Helsinki)
Annales Medicinae Experimentalis et Biologiae Fenniae (Helsinki) *(Finland)*

Ann. Med. Internae Fenniae
Annales Medicinae Internae Fenniae *(Finland)*

Ann. Med. Navale (Rome)
Annali di Medicina Navale (Rome) (formerly Annali di Medicina Navale e Tropicale) *(Italy)*

Ann. Nutr. Aliment.
Annales de la Nutrition et de l'Alimentation *(France)*

Ann. N. Y. Acad. Sci.
*Annals of the New York Academy of Sciences *(U. S.)*

Ann. Occupational Hyg.
*Annals of Occupational Hygiene *(England)*

Ann. Oculist.
Annales d'Oculistique *(France)*

Ann. Ostet. Ginecol.
*Annali di Ostetricia e Ginecologia *(Italy)*

Annotationes Zool. Japon.
Annotationes Zoologicae Japonenses *(Japan)*

Ann. Oto-Laryngol.
Annales d'Oto-Laryngologie, Les *(France)*

Ann. Otol. Rhinol. Laryngol.
Annals of Otology, Rhinology, and Laryngology *(U. S.)*

Ann. Ottalmol. Clin. Oculist.
Annali di Ottalmologia e Clinica Oculistica *(Italy)*

Ann. Paediat. Fenniae
*Annales Paediatriae Fenniae *(Finland)*

Ann. Paediat. Japon.
*Annales Paediatrici Japonici, Kioto Universitatis *(Japan)*

Ann. Pharm. Franc.
Annales Pharmaceutiques Francaises *(France)*

Ann. Phys. (N. Y.)
*Annals of Physics (New York) *(U. S.)*

Ann. Phys. (Paris)
*Annales de Physique (Paris) *(France)*

Ann. Physik
*Annalen der Physik *(Germany)*

Ann. Radioelec.
*Annales de Radioelectricite *(France)*

Ann. Radiol.
*Annales de Radiologie *(France)*

Ann. Rept. Eng. Res. Inst.
Annual Report of the Engineering Research Institute
see **Sogo Shikensho Nempo**

Ann. Rept. Japan. Assoc. Radiation Res. Polymers
Annual Report of the Japanese Association for Radiation Research on Polymers
see **Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo**

Ann. Rept. Radiation Center Osaka Prefect.
*Annual Report of the Radiation Center of Osaka Prefecture *(Japan)*

Ann. Rept. Sci. Works, Fac. Sci., Osaka Univ.
Annual Report of Scientific Works, Faculty of Science, Osaka University *(Japan)*

Ann. Rev. Astronomy Astrophys.
Annual Review of Astronomy and Astrophysics *(U. S.)*

Ann. Rev. Med.
*Annual Review of Medicine *(U. S.)*

Ann. Rev. Microbiol.
Annual Review of Microbiology *(U. S.)*

Ann. Rev. Nucl. Sci.
*Annual Review of Nuclear Science *(U. S.)*

Ann. Rev. Pharmacol.
*Annual Review of Pharmacology *(U. S.)*

Ann. Rev. Phys. Chem.
*Annual Review of Physical Chemistry *(U. S.)*

Ann. Rheumatic Diseases
*Annals of the Rheumatic Diseases *(England)*

Ann. Roy. Coll. Surg. Engl.
Annals of the Royal College of Surgeons of England *(England)*

Ann. Sclavo
*Annali Sclavo *(Italy)*

Ann. Soc. Sci. Bruxelles. Ser. I
*Annales de la Societe Scientifique de Bruxelles. Serie I *(Belgium)*

Ann. Surg.
Annals of Surgery *(U. S.)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. AA
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio AA *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. D
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio D *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. E
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio E *(Poland)*

Ann. Univ. Saraviensis, Med.
Annales Universitatis Saraviensis, Medizin-Medecine *(Germany)*

Anotaciones Pediat. (Medellin, Colombia)
*Anotaciones Pediatricas (Medellin, Colombia) *(Colombia)*

Antibiotiki
Antibiotiki† *(U.S.S.R.)*

APCA (Air Pollution Control Assoc.) Abstr.
*APCA (Air Pollution Control Association) Abstracts *(U. S.)*

Appl. Mater. Res.
Applied Materials Research (formerly Materials Research) *(England)*

Appl. Microbiol.
*Applied Microbiology *(U. S.)*

Appl. Opt.
*Applied Optics *(U. S.)*

Appl. Phys. Letters
*Applied Physics Letters *(U. S.)*

Appl. Sci. Res., Sect. A
*Applied Scientific Research, Section A *(Netherlands)*

Appl. Sci. Res., Sect. B
*Applied Scientific Research, Section B *(Netherlands)*

Appl. Spectry.
*Applied Spectroscopy *(U. S.)*

Appl. Therap.
Applied Therapeutics *(Canada)*

Arbeitsschutz
Arbeitsschutz *(Germany)*

Arbok Univ. Bergen, Mat.-Nat. Ser.
*Arbok for Universitetet i Bergen, Matematikk-Naturvitenskap Serie *(Norway)*

Arch. Anat. Microscop. Morphol. Exptl.
*Archives d'Anatomie Microscopique et de Morphologie Experimentale *(France)*

Arch. Arg. Pediat.
Archivos Argentinos de Pediatria *(Argentina)*

Arch. Automat. Telemech.
*Archiwum Automatyki i Telemechaniki *(Poland)*

Arch. Biochem. Biophys.
*Archives of Biochemistry and Biophysics *(U. S.)*

Arch. Biol. (Liege)
*Archives de Biologie (Liege) *(Belgium)*

Arch. Bioquim., Quim. Farm. Tucuman
*Archivos de Bioquimica, Quimica y Farmacia, Tucuman *(Argentina)*

Arch. Bodowy Maszyn
*Archiwum Bodowy Maszyn *(Poland)*

Arch. Chir. Neerl.
Archivum Chirurgicum Neerlandicum *(Netherlands)*

Arch. Dermatol.
Archives of Dermatology (formerly A.M.A. Archives of Dermatology) *(U. S.)*

Arch. "De Vecchi" Anat. Patol. Med. Clin.
Archivio "De Vecchi" per l'Anatomia Patologica e la Medicina Clinica *(Italy)*

Arch. Eisenhuettenw.
Archiv fuer das Eisenhuettenwesen *(Germany)*

Arch. Elektrotech.
*Archiwum Elektrotechniki *(Poland)*

Arch. Elek. Uebertrag.
Archiv der Elektrischen Uebertragung *(Germany)*

Arch. Entwicklungsmech. Organ.
Archiv fuer Entwicklungsmechanik der Organismen, Wilhelm Roux' *(Germany)*

Arch. Environ. Health
*Archives of Environmental Health (formerly A.M.A. Archives of Industrial Health) *(U. S.)*

Arch. Exptl. Pathol. Pharmakol.
Archiv fuer Experimentelle Pathologie und Pharmakologie, Naunyn-Schmiedebergs *(Germany)*

Arch. Fisiol.
Archivio di Fisiologia *(Italy)*

Arch. Ges. Physiol.
Archiv fuer die Gesamte Physiologie des Menschen und der Tiere, Pfluegers *(Germany)*

Arch. Gornictwa
*Archiwum Gornictwa *(Poland)*

Arch. Hosp. Univ. (Havana)
*Archivos de Hospitales Universitarios (Havana) (formerly Archivos del Hospital Universitario) *(Cuba)*

Arch. Hosp. Vargas (Caracas)
*Archivos del Hospital Vargas (Caracas) *(Venezuela)*

Arch. Hutnictwa
*Archiwum Hutnictwa *(Poland)*
Arch. Hyg. Bakteriol.
*Archiv fuer Hygiene und Bakteriologie *(Germany)*
Arch. Immunol. Terapii Doswiadczalnej
Archiwum Immunologii i Terapii Doswaidczalnej
see **Arch. Immunol. Therap. Exptl.**
Arch. Immunol. Therap. Exptl.
*Archivum Immunologiae et Therapiae Experimentalis *(Poland)*
Arch. Interam. Rheumatol.
*Archives of Interamerican Rheumatology *(Brazil)*
Arch. Internal Med.
Archives of Internal Medicine (formerly A.M.A. Archives of Internal Medicine) *(U. S.)*
Arch. Intern. Pharmacodyn.
*Archives Internationales de Pharmacodynamie et de Therapie *(Belgium)*
Arch. Intern. Physiol. Biochim.
Archives Internationales de Physiologie et de Biochimie *(Belgium)*
Arch. Ital. Anat. Istol. Patol.
Archivio Italiano di Anatomia e Istologia Patologica *(Italy)*
Arch. Ital. Biol.
*Archives Italiennes de Biologie *(Italy)*
Arch. Ital. Otol. Rinol. Laringol.
Archivio Italiano di Otologia, Rinologia e Laringologia *(Italy)*
Arch. Ital. Sci. Farmacol.
Archivo Italiano di Scienze Farmacologiche *(Italy)*
Arch. Kinderheilk.
Archiv fuer Kinderheilkunde *(Germany)*
Arch. Klin. Exptl. Dermatol.
Archiv fuer Klinische und Experimentelle Dermatologie *(Germany)*
Arch. Maladies App. Digest. Maladies Nutr.
Archives des Maladies de l'Appareil Digestif et des Maladies de la Nutrition *(France)*
Arch. Maladies Profess. Med. Trav. Securite Sociale
Archives des Maladies Professionnelles de Medecine du Travail et de Securite Sociale *(France)*
Arch. Mech. Stosowanej
Archiwum Mechaniki Stosowanej *(Poland)*
Arch. Med. Mex.
*Archivos Medicos Mexicanos *(Mexico)*
Arch. Meterol., Geophys. Bioklimatol., Ser. A
Archiv fuer Meterologie, Geophysik und Bioklimatologie, Series A *(Austria)*
Arch. Mikrobiol.
Archiv fuer Mikrobiologie *(Germany)*
Arch. Neurol.
Archives of Neurology *(U. S.)*
Arch. Oftalmol. Buenos Aires
Archivos de Oftalmologia de Buenos Aires *(Argentina)*
Arch. Ohren, Nasen, Kehlkopfheilk.
Archiv fuer Ohren-, Nasen- und Kehlkopfheilkunde, Vereinigt mit Zeitschrift fuer Hals-, Nasen- und Ohrenheilkunde *(Germany)*
Arch. Ophthalmol. (Berlin)
Archiv fuer Ophthalmologie Vereinigt mit Archiv fuer Augenheilkunde, Albrecht von Graefes (Berlin) *(Germany)*
Arch. Ophthalmol. (Chicago)
Archives of Ophthalmology (Chicago) *(U. S.)*
Arch. Oral Biol.
Archives of Oral Biology *(England)*
Arch. Ortoped.
Archivio di Ortopedia *(Italy)*
Arch. Ostet. Ginecol.
Archivio di Ostetricia e Ginecologia *(Italy)*
Arch. Otolaryngol.
Archives of Otolaryngology *(U. S.)*
Arch. Pathol.
*Archives of Pathology (formerly A.M.A. Archives of Pathology) *(U. S.)*
Arch. Peru. Patol. Clin. (Lima)
*Archivos Peruanos de Pathologia y Clinica (Lima) *(Peru)*
Arch. Pharm.
Archiv der Pharmazie und Berichte der Deutschen Pharmazeutischen Gesellschaft (includes Mitteilungen der Deutschen Pharmazeutischen Gesellschaft und der Pharmazeutischen Gesellschaft der DDR) *(Germany)*
Arch. Physik. Therapie
Archiv fuer Physikalische Therapie, Balneologie und Klimatologie *(Germany)*
Arch. Phys. Med. Rehabil.
Archives of Physical Medicine and Rehabilitation *(U. S.)*
Arch. Psychiat. Nervenkrankh.
Archiv fuer Psychiatrie und Nervenkrankheiten Vereinigt mit Zeitschrift fuer die Gesamte Neurologie und Psychiatrie *(Germany)*
Arch. Roumaines Pathol. Exptl. Microbiol.
*Archives Roumaines de Pathologie Experimentale et de Microbiologie *(France)*
Arch. Sci. Med.
Archivio per le Scienze Mediche *(Italy)*
Arch. Sci. Physiol.
Archives des Sciences Physiologiques *(France)*
Arch. Soc. Biol. Montevideo
Archivos de la Sociedad de Biologia de Montevideo *(Uruguay)*
Arch. Soc. Estud. Clin. Habana
*Archivos de la Sociedad de Estudios Clinicos de la Habana *(Cuba)*
Arch. Surg.
Archives of Surgery *(U. S.)*
Arch. Tech. Messen
Archiv fuer Technisches Messen und Industrielle Messtechnik *(Germany)*
Arch. Union Med. Balkan.
Archives de l'Union Medicale Balkanique *(Romania)*
Arch. Venezolanos Patol. Trop. Parisitol. Med.
*Archivos Venezolanos de Patologia Tropical y Parasitologia Medica *(Venezuela)*
Arctic
Arctic *(Canada)*
Argonne Natl. Lab. Rev.
*Argonne National Laboratory Reviews (supersedes News-Bulletin International (Argonne National Laboratory)) *(U. S.)*
Arhiv Biol. Nauka (Belgrade)
Arhiv Bioloskih Nauka (Belgrade) *(Yugoslavia)*
Arhiv Farm. (Belgrade)
Archiv za Farmaciju (Belgrade) *(Yugoslavia)*
Arhiv Hig. Rada Toksikol.
Arhiv za Higijenu Rada i Toksikologiju (formerly Arhiv za Higijenu Rada) *(Yugoslavia)*
Arkh. Anat., Gistol. i Embriol.
Arkhiv Anatomii, Gistologii i Embriologii *(U.S.S.R.)*
Arkiv Astron.
Arkiv for Astronomi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*
Arkiv Fysik
*Arkiv for Fysik *(Sweden)*
Arkiv Fys. Seminar Trondheim
*Arkiv for det Fysiske Seminar i Trodheim *(Norway)*
Arkiv Geofysik
Arkiv for Geofysik, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*
Arkiv Mineral. Geol.
Arkiv for Mineralogi och Geologi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*
Armed Forces Chem. J.
Armed Forces Chemical Journal *(U. S.)*
Arquiv. Brasil. Cardiol.
*Arquivos Brasileiros de Cardiologia *(Brazil)*
Arquiv. I.B.I.T. (Inst. Brasil. Invest. Tuberc.)
*Arquivos do I.B.I.T. (Instituto Brasileiro para Investigacao da Tuberculose) *(Brazil)*
Arquiv. Mineiros Leprol.
*Arquivos Mineiros de Leprologia *(Brazil)*
Arquiv. Patol. (Lisbon)
*Arquivos de Patologia (Lisbon) *(Portugal)*
Arquiv. Tisiol.
*Arquivos de Tisiologia *(Portugal)*
Arthritis Rheumat.
*Arthritis and Rheumatism *(U. S.)*
Arzneimittel-Forsch.
Arzneimittel-Forschung *(Germany)*
Assoc. Belge Develop. Pacifique Energie At., Bull. Inform.
Association Belge pour le Development Pacifique de l'Energie Atomique, Bulletin d'Information *(Belgium)*
Assoc. Food Drug Officials U. S., Quart. Bull.
Association of Food & Drug Officials of the United States, Quarterly Bulletin *(U. S.)*
Astronaut. Acta
*Astronautica Acta *(Austria)*
Astronaut. Aeronaut.
*Astronautics & Aeronautics (formerly Astronautics and

Aerospace Engineering) *(U. S.)*

Astronautyka
*Astronautyka *(Poland)*

Astron. Zh.
Astronomicheskii Zhurnal† *(U.S.S.R.)*

Astrophys. J.
*Astrophysical Journal, The *(U. S.)*

Astrophys. J., Suppl. Ser.
*Astrophysical Journal, The, Supplement Series *(U. S.)*

Astrophys. Norvegica
*Astrophysica Norvegica *(Norway)*

Ateneo Parmense
*Ateneo Parmense, L' *(Italy)*

At. Energ. (USSR)
*Atomnaya Energiya† *(U.S.S.R.)*

At. Energy Australia
*Atomic Energy in Australia *(Australia)*

At. Energy Rev.
*Atomic Energy Review *(Austria)*

At. Kozlemen.
*Atomki Kozlemenyek (formerly carried under the title: Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek) *(Hungary)*

Atomdokumentation
*Atomdokumentation. Selektiv Litteraturlesta *(Sweden)*

Atomics
Atomics *(U. S.)*

Atomkernenergie
*Atomkernenergie (formerly Atomenergie) *(Germany)*

ATOMKI (Atom. Kut. Int.) Kozlemen., Melleklet
ATOMKI (Atommag Kutato Intezet) Kozlemenyek, Melleklet *(Hungary)*

Atomlight
*Atomlight *(U. S.)*

Atomo, Petrol. Elettricita
Atomo, Petrolio, Elettricita *(Italy)*

Atompraxis
*Atompraxis *(Germany)*

Atomtech. Tajekoztato
*Atomtechnikai Tajekoztato *(Hungary)*

Atomwirtschaft
*Atomwirtschaft, Die *(Germany)*

Atoomenergie Haar Toepassingen
*Atoomenergie en Haar Toepassingen (formerly RCN Bulletin) *(Netherlands)*

At. Strom
*Atom und Strom *(Germany)*

Atti Accad. Med. Lombarda
Atti della Accademia Medica Lombarda *(Italy)*

Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat.
*Atti della Accademia Nazionale dei Lincei. Rendiconti, Classe di Scienze Fisiche, Matematiche e Naturali *(Italy)*

Atti Accad. Sci. Torino: I. Classe Sci. Fis., Mat. Nat.
*Atti della Accademia delle Scienze di Torino. Part I. Classe Scienze Fisiche, Matematiche e Naturali *(Italy)*

Atti Assoc. Genet. Ital.
*Atti Associazone Genetica Italiana *(Italy)*

Atti, Congr. Nazl. Radiol. Med. Med. Nucl., 22, Catania, 1963
Atti, Congresso Nazionale di Radiologia Medica e Medicina Nucleare, 22° [Congresso], Catania, May 13–16, 1963 *(Italy)*

Atti, Ist. Veneto Sci., Lettere Arti, Classe Sci. Mat. Nat.
Atti, Istituto Veneto di Scienze, Lettere ed Arti, Classe di Scienze Matematiche e Naturali *(Italy)*

Atti Seminar. Mat. Fis. Univ. Modena
*Atti del Seminario Matematico e Fisico dell'Universita di Modena *(Italy)*

Atti Soc. Ital. Cardiol.
Atti della Societa Italiana di Cardiologia *(Italy)*

Atti Soc. Ital. Sci. Vet.
Atti della Societa Italiana de Scienze Veterinarie *(Italy)*

Atti Soc. Nat. Mat. Modena
*Atti della Societa dei Naturalisti e Matematici di Modena *(Italy)*

Atti Soc. Peloritana Sci. Fis. Mat. Nat.
Atti della Societa Peloritana di Scienze Fisiche Matematiche e Naturali *(Italy)*

Attualita Ostet. Ginecol.
Attualita di Ostetrica e Ginecologia *(Italy)*

Australasian Ann. Med.
Australasian Annals of Medicine *(Australia)*

Australian Dental J.
Australian Dental Journal *(Australia)*

Australian J. Agr. Res.
Australian Journal of Agricultural Research *(Australia)*

Australian J. Appl. Sci.
Australian Journal of Applied Science *(Australia)*

Australian J. Biol. Sci.
*Australian Journal of Biological Sciences *(Australia)*

Australian J. Chem.
*Australian Journal of Chemistry *(Australia)*

Australian J. Exptl. Biol. Med. Sci.
Australian Journal of Experimental Biology and Medical Science, The *(Australia)*

Australian J. Phys.
*Australian Journal of Physics *(Australia)*

Australian J. Sci.
*Australian Journal of Science, The *(Australia)*

Automatisme
Automatisme *(France)*

Automazione Automatismi
*Automazione e Automatismi *(Italy)*

Automazione Strumentazione
Automazione e Strumentazione *(Italy)*

Avian Diseases
Avian Diseases *(U. S.)*

Aviation Week Space Technol.
Aviation Week & Space Technology *(U. S.)*

Azerb. Khim. Zh.
*Azerbaidzhanskii Khimicheskii Zhurnal *(Azerbaidzhan S.S.R.)*

Bacteriol. Rev.
Bacteriological Reviews *(U. S.)*

Battelle Tech. Rev.
*Battelle Technical Review *(U. S.)*

Bayer. Landwirtsch. Jahrb.
Bayerisches Landwirtschaftliches Jahrbuch *(Germany)*

BCIRA (Brit. Cast Iron Res. Assoc.) J.
BCIRA (British Cast Iron Research Association) Journal *(England)*

Beitr. Pathol. Anat. Allgem. Pathol.
*Beitraege zur Pathologischen Anatomie und zur Allgemeinen Pathologie *(Germany)*

Beitr. Plasmaphysik
*Beitraege aus der Plasmaphysik *(Germany)*

Belgicatom, Assoc. Belge Develop. Pacifique Energie At., Bull. Inform.
Belgicatom, Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information (formerly Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Belg. Tijdschr. Geneesk.
Belgisch Tijdschrift voor Geneeskunde *(Belgium)*

Bell Lab. Record
Bell Laboratories Record *(U. S.)*

Bell System Tech. J.
Bell System Technical Journal, The *(U. S.)*

Ber. Bunsenges. Physik. Chem.
*Berichte der Bunsengesellschaft fuer Physikalische Chemie (formerly Zeitschrift fuer Elektrochemie) *(Germany)*

Ber. Deut. Keram. Ges.
*Berichte der Deutschen Keramischen Gesellschaft e. V. *(Germany)*

Bergakademie
Bergakademie, Die *(Germany)*

Berlin. Med. Rundschau
Berliner Medizinische Rundschau *(Germany)*

Berufsdermatosen
Berufsdermatosen *(Germany)*

Bibliotheca Haematol.
Bibliotheca Haematologica, Supplementa ad Acta Haematologica *(Switzerland)*

Biken's J.
Biken's Journal *(Japan)*

Bilten Inst. Nukl. Nauke "Boris Kidric"
Bilten Instituta za Nuklearne Nauke "Boris Kidric"† *(Yugoslavia)*

Biochem. Biophys. Res. Commun.
*Biochemical and Biophysical Research Communications *(U. S.)*

Biochemistry
*Biochemistry *(U. S.)*

Biochemistry (Tokyo)
Biochemistry (Tokyo)
see Seikagaku

Biochemistry (USSR) (English Transl.)
*Biochemistry (USSR) (English Translation of Biokhimiya) *(U. S.)*

Biochem. J.
*Biochemical Journal *(England)*

Biochem. Pharmacol.
*Biochemical Pharmacology *(England)*

Biochem. Z.
Biochemische Zeitschrift *(Germany)*

Biochim. Biophys. Acta
*Biochimica et Biophysica Acta *(U. S.)*

Biofizika
Biofizika† *(U.S.S.R.)*

Biokhimiya
Biokhimiya† *(U.S.S.R.)*

Biol. Bull.
Biological Bulletin, The *(U. S.)*

Biol. Kozlemen.
Biologiai Kozlemenyek *(Hungary)*

Biol. Neonatorum
*Biologia Neonatorum *(Switzerland)*

Biologia
Biologia *(Czechoslovakia)*

Biologica (Santiago)
Biologica (Santiago) *(Chile)*

Biol. Plant., Acad. Sci. Bohemoslov.
Biologia Plantarum, Academia Scientiarum Bohemoslovenica *(Czechoslovakia)*

Biol. Rev. Cambridge Phil. Soc.
Biological Reviews of the Cambridge Philosophical Society *(England)*

Biomed. Sci. Instr.
Biomedical Sciences Instrumentation *(U. S.)*

Biophysics (USSR) (English Transl.)
*Biophysics (USSR) (English Translation of Biofizika) *(England)*

Biophysik
*Biophysik *(Germany)*

Biophys. J.
*Biophysical Journal *(U. S.)*

Biophys. J., Suppl.
*Biophysical Journal, Supplement *(U. S.)*

Biophys. Soc. Abstr.
*Biophysical Society Abstracts *(U. S.)*

Biopolymers
Biopolymers (supersedes in part the Journal of Polymer Science) *(U. S.)*

BioScience
BioScience (formerly The A.I.B.S. (American Institute of Biological Sciences) Bulletin) *(U. S.)*

Biotechnol. Bioeng.
Biotechnology and Bioengineering (formerly Journal of Biochemical and Microbiological Technology and Engineering) *(England)*

Bitamin
Bitamin (Vitamins (Kyoto)) *(Japan)*

Biul. Inst. Roslin Leczniczych
Biuletyn Instytutu Roslin Leczniczych *(Poland)*

Blood
*Blood. The Journal of Hematology *(U. S.)*

Blut
Blut *(Germany)*

Boei Eisei
*Boei Eisei (National Defense Medical Journal) *(Japan)*

Bol. Asoc. Med. Puerto Rico
*Boletin de la Asociacion Medica de Puerto Rico *(Puerto Rico)*

Bol. Fac. Ing. Agri-Mensura Montevideo
*Boletin de la Facultad de Ingenieria y Agri-Mensura de Montevideo *(Uruguay)*

Bol. Hosp. Oftalmol. Nuestra Senora de la Luz
*Boletin del Hospital Oftalmologico de Nuestra Senora de la Luz *(Mexico)*

Bol. Inst. Estud. Med. Biol. (Mex.)
*Boletin del Instituto de Estudios Medicos y Biologicos *(Mexico)*

Bol. Inst. Mat. Astron. Fis.
*Boletin del Instituto de Matematica Astronomia y Fisica *(Argentina)*

Bol. Junta Control Energia At. (Peru)
*Boletin de la Junta do Control de Energia Atomica (formerly Boletin de Informaciones de la Junta do Control de Energia Atomica) *(Peru)*

Boll. Chim. Farm.
Bollettino Chimico Farmaceutico *(Italy)*

Boll. Ist. Sieroterap. Milan.
*Bollettino dell'Istituto Sieroterapico Milanese *(Italy)*

Boll. Mal. Orecchio, Gola, Naso
Bollettino delle Malattie dell'Orecchio, della Gola, del Naso *(Italy)*

Boll. Oculist.
Bollettino d'Oculistica *(Italy)*

Boll. Sci. Med.
Bollettino delle Scienze Mediche *(Italy)*

Boll. Soc. Ital. Biol. Sper.
Bollettino della Societa Italiana di Biologia Sperimentale *(Italy)*

Boll. Soc. Med.-Chir. Cremona
Bollettino Societa Medico-Chirurgica Cremona *(Italy)*

Bol. Real Soc. Espan. Hist. Nat. Secc. Biol.
Boletin de la Real Sociedad Espanola de Historia Natural, Seccion Biologica *(Spain)*

Bol. Soc. Cubana Dermatol. Sifilog.
*Boletin de la Sociedad Cubana de Dermatologia y Sifilografia *(Cuba)*

Bol. Soc. Med. Centro Materno "Gral. Maximino Avila Camacho"
*Boletin de la Sociedad Medica del Centro Materno "Gral. Maximino Avila Camacho" *(Mexico)*

Bol. Trab. Soc. Cir. Buenos Aires
*Boletines y Trabajos; Sociedad de Cirugia de Buenos Aires *(Argentina)*

Bol. Univ. Parana, Fis. Teorica
*Boletim da Universidade do Parana, Fisica Teorica *(Brazil)*

Bombay Technologist
Bombay Technologist *(India)*

Botan. Bull. Acad. Sinica (Taiwan)
*Botanical Bulletin of Academia Sinica (Taiwan) *(China)*

Botan. Mag. (Tokyo)
Botanical Magazine, The (Tokyo) *(Japan)*

Bratislav. Lekarske Listy
Bratislavske Lekarske Listy *(Czechoslovakia)*

Brennstoff-Waerme-Kraft
*Brennstoff-Waerme-Kraft *(Germany)*

Brigham Young Univ. Sci. Bull., Biol. Ser.
*Brigham Young University Science Bulletin, Biological Series *(U. S.)*

Brit. Chem. Eng.
*British Chemical Engineering *(England)*

Brit. Columbia Med. J.
*British Columbia Medical Journal *(Canada)*

Brit. Commun. Electron.
British Communications & Electronics *(England)*

Brit. Heart J.
British Heart Journal *(England)*

Brit. J. Anaesthesia
British Journal of Anaesthesia *(England)*

Brit. J. Appl. Phys.
*British Journal of Applied Physics *(England)*

Brit. J. Cancer
*British Journal of Cancer *(England)*

Brit. J. Dermatol.
British Journal of Dermatology *(England)*

Brit. J. Haematol.
British Journal of Haematology *(England)*

Brit. J. Non-Destructive Testing
British Journal of Non-Destructive Testing *(England)*

Brit. J. Nutr.
British Journal of Nutrition, The *(England)*

Brit. J. Ophthalmol.
British Journal of Ophthalmology *(England)*

Brit. J. Plastic Surg.
British Journal of Plastic Surgery *(Scotland)*

Brit. J. Prevent. Social Med.
British Journal of Preventive & Social Medicine *(England)*

Brit. J. Radiol.
*British Journal of Radiology *(England)*

Brit. J. Surg.
British Journal of Surgery, The *(England)*

Brit. J. Urol.
British Journal of Urology, The *(Scotland)*

Brit. Med. Bull.
British Medical Bulletin *(England)*

Brit. Med. J.
British Medical Journal, The *(England)*

Brit. Vet. J.
British Veterinary Journal, The *(England)*

Bruxelles-Med.
Bruxelles-Medical *(Belgium)*

Bryologist
Bryologist, The *(U. S.)*

Bul. Inst. Politeh. Bucuresti
Buletinul Institutului Politehnic Bucuresti *(Romania)*

Bull. Acad. Natl. Med. (Paris)
Bulletin de l'Academie Nationale de Medecine (Paris) *(France)*

Bull. Acad. Polon. Sci., Ser. Sci. Biol.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Biologiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci. Chim.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Chimiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci. Geol. Geograph.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Geologiques et Geographiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences, Mathematiques, Astronomiques et Physiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci., Tech.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Techniques *(Poland)*

Bull. Aeron. Res. Inst., Univ. Tokyo
Bulletin of the Aeronautical Research Institute, University of Tokyo
see Tokyo Daigaku Koku Kenkyusho Shuho

Bull. Assoc. Franc. Etude Cancer
Bulletin de l'Association Francaise pour l'Etude du Cancer *(France)*

Bull. Astron. Inst. Czech.
*Bulletin of the Astronomical Institutes of Czechoslovakia *(Czechoslovakia)*

Bull. Atmospheric Radioactivity (Japan)
Bulletin of the Atmospheric Radioactivity (Japan)
see Taiki Hoshano Kensoku Seiseki

Bull. Biol. France Belg.
Bulletin Biologique de la France et de la Belgique *(France)*

Bull. Boris Kidrich Inst. Nucl. Sci.
*Bulletin of the Boris Kidrich Institute of Nuclear Sciences *(Yugoslavia)*

Bull. Cancer Inst. Okayama Univ. Med. School
Bulletin of the Cancer Institute, Okayama University Medical School, The *(Japan)*

Bull. Cercle Etudes Metaux
Bulletin du Cercle d'Etudes des Metaux *(France)*

Bull. Chem. Soc. Japan
*Bulletin of the Chemical Society of Japan *(Japan)*

Bull. Classe Sci., Acad. Roy. Belg.
*Bulletin de la Classe des Sciences, Academie Royale de Belgique *(Belgium)*

Bull. Electrotech. Lab. (Tokyo)
Bulletin of the Electrotechnical Laboratory (Tokyo)
see Denki Shikensho Iho

Bull. Exptl. Biol. Med. (USSR) (English Transl.)
Bulletin of Experimental Biology and Medicine (USSR) (English Translation of Byulleten Eksperimental'noi Biologii i Meditsiny) *(U. S.)*

Bull. Fac. Med. Istanbul
Bulletin de la Faculte de Medecine d'Istanbul *(Turkey)*

Bull. Fac. Pharm. (Cairo Univ.)
Bulletin of the Faculty of Pharmacy (Cairo University) *(Egypt)*

Bull. Federation Soc. Gynecol. Obstet. Langue Franc.
Bulletin de la Federation des Societes de Gynecologie et d'Obstetrique de Langue Francaise *(France)*

Bull. Georgia Acad. Sci.
Bulletin of the Georgia Academy of Science *(U. S.)*

Bull. Heart Inst., Japan
*Bulletin of the Heart Institute, Japan *(Japan)*

Bull. Hosp. Joint Diseases
*Bulletin of the Hospital for Joint Diseases *(U. S.)*

Bull. Inform. Appl. Ind. Radioelements
*Bulletin d'Information sur les Applications Industrielles des Radioelements. Supplement au Bulletin d'Information de l'A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*

Bull. Inform. Assoc. Belge Develop. Pacifique Energie At.
*Bulletin d'Information de l'Association Belge pour le Developpement Pacifique de l'Energie Atomique *(Belgium)*

Bull. Inform. A.T.E.N. (Assoc. Tech. Energie Nucl.)
*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*

Bull. Inform. Sci. Tech. (Paris)
*Bulletin d'Information Scientifique et Technique (Paris) *(France)*

Bull. Inst. Agron. Sta. Rech. Gembloux
Bulletin de l'Institut Agronomique et des Stations de Recherches de Gembloux *(Belgium)*

Bull. Inst. Chem., Acad. Sinica
*Bulletin of the Institute of Chemistry, Academia Sinica *(China)*

Bull. Inst. Chem. Res., Kyoto Univ.
*Bulletin of the Institute for Chemical Research, Kyoto University *(Japan)*

Bull. Inst. Nucl. Sci. "Boris Kidrich" (Belgrade)
*Bulletin of the Institute of Nuclear Science "Boris Kidrich" (Belgrade) *(Yugoslavia)*

Bull. Inst. Public Health (Tokyo)
Bulletin of the Institute of Public Health (Tokyo)
see Koshu Eiseiin Kenkyu Hokoku

Bull. Japan. Soc. Sci. Fisheries
Bulletin of the Japanese Society of Scientific Fisheries
see Nippon Suisan Gakkaishi

Bull. Johns Hopkins Hosp.
Bulletin of the Johns Hopkins Hospital *(U. S.)*

Bull. JSME (Japan Soc. Mech. Engrs.)
Bulletin of JSME (Japan Society of Mechanical Engineers) *(Japan)*

Bull. Korean Acad. Sci.
Bulletin of the Korean Academy of Sciences
see Chosun Kwahakwon Tongbo

Bull. Math. Biophys.
Bulletin of Mathematical Biophysics *(U. S.)*

Bull. Mineral Res. Exploration Inst. Turkey, Foreign Ed.
*Bulletin of the Mineral Research and Exploration Institute of Turkey, Foreign Edition *(Turkey)*

Bull. Natl. Inst. Agr. Sci., Ser. G
Bulletin of the National Institute of Agricultural Sciences, Series G
see Nogyo Gijutsu Kenkyusho Hokoku, Chikusan

Bull. N. Y. Acad. Med.
*Bulletin of the New York Academy of Medicine *(U. S.)*

Bull. Osaka Munic. Tech. Res. Inst.
Bulletin of the Osaka Municipal Technical Research Institute
see Osaka Shiritsu Kogyo Kenkyusho Hokoku

Bull. Parenteral Drug Assoc.
Bulletin of the Parenteral Drug Association *(U. S.)*

Bull. Pharm. (Peking)
Bulletin of Pharmacology (Peking)
see Yao Hsueh T'ung Pao

Bull. Post-Graduate Comm. Med., Univ. Sydney
Bulletin of the Post-Graduate Committee in Medicine, University of Sydney *(Australia)*

Bull. Rheumatic Diseases
*Bulletin on Rheumatic Diseases *(U. S.)*

Bull. Schweiz. Akad. Med. Wiss.
Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften *(Switzerland)*

Bull. Schweiz. Elektrotech. Ver.
Bulletin des Schweizerischen Elektrotechnischen Vereins *(Switzerland)*

Bull. Sci., Conseil Acad. RPF Yougoslavie
*Bulletin Scientifique, Conseil des Acqdemies de la RPF Yougoslavie *(Yugoslavia)*

Bull. Sci. Eng. Res. Lab., Waseda Univ.
Bulletin of Scientific and Engineering Research Laboratory, Waseda University
see Waseda Daigaku Rikogaku Kenkyusho Hokoku

Bull. Seismol. Soc. Am.
Bulletin of the Seismological Society of America *(U. S.)*

Bull. Soc. Amis Sci. Lettres Poznan, Ser. C
Bulletin de la Societe des Amis des Sciences et des Lettres de Poznan, Serie C *(Poland)*

Bull. Soc. Belge Geol., Paleontol. Hydrol.
Bulletin de la Societe Belge de Geologie, de Paleontologie et d'Hydrologie *(Belgium)*

Bull. Soc. Chim. Belges
*Bulletin des Societes Chimiques Belges *(Belgium)*

Bull. Soc. Chim. Biol.
Bulletin de la Societe de Chimie Biologique *(France)*

Bull. Soc. Chim. France
*Bulletin de la Societe Chimique de France *(France)*

Bull. Soc. Franc. Ceram.
Bulletin de la Societe Francaise de Ceramique *(France)*

Bull. Soc. Franc. Electriciens
Bulletin de la Societe Francaise des Electriciens *(France)*

Bull. Soc. Franc. Mineral. Crist.
*Bulletin de la Societe Francaise de Mineralogie et de Cristallographie *(France)*

Bull. Soc. Intern. Chir.
Bulletin de la Societe Internationale de Chirurgie *(Belgium)*

Bull. Soc. Ophthalmol. France
Bulletin des Societes d'Ophtalmologie de France *(France)*

Bull. Soc. Roy. Belge Gynecol. Obstet.
*Bulletin de la Societe Royale Belge de Gynecologie et d'Obstetrique *(Belgium)*

Bull. Soc. Roy. Sci. Liege
*Bulletin de la Societe Royale des Sciences de Liege *(Belgium)*

Bull. Soc. Sci. Bretagne
Bulletin de la Societe Scientifique de Bretagne *(France)*

Bull. Soc. Sci. Med. Luxembourg
Bulletin de la Societe des Sciences Medicales du Grand-Duche de Luxembourg *(Luxembourg)*

Bull. Soc. Vaudoise Sci. Nat.
Bulletin de la Societe Vaudoise des Sciences Naturelles *(Switzerland)*

Bull. Textile Res. Inst. Japan. Govt.
Bulletin of the Textile Research Institute of Japanese Government
see **Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku**

Bull. Tokyo Inst. Technol.
Bulletin of the Tokyo Institute of Technology *(Japan)*

Bull. Tokyo Inst. Technol., Ser. B
Bulletin of the Tokyo Institute of Technology, Series B *(Japan)*

Bull. Tokyo Med. Dental Univ.
Bulletin of Tokyo Medical and Dental University *(Japan)*

Bull. Univ. Osaka Prefect., Ser. A
Bulletin of the University of Osaka Prefecture, Series A *(Japan)*

Bull. Univ. Osaka Prefect., Ser. B
Bulletin of the University of Osaka Prefecture, Series B *(Japan)*

Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser.
Bulletin of the Virginia Polytechnic Institute, Engineering Experiment Station Series *(U. S.)*

Bull. World Health Organ.
Bulletin of the World Health Organization *(U. S.)*

Bunko Kenkyu
Bunko Kenkyu (Journal of the Spectroscopical Society of Japan) *(Japan)*

Bunseki Kagaku
*Bunseki Kagaku (Japan Analyst) *(Japan)*

Burma Med. J.
*Burma Medical Journal *(Burma)*

Byul. Eksperim. Biol. i Med.
*Byulleten Eksperimental'noi Biologii i Meditsiny† *(U.S.S.R.)*

Byul. Mosk. Obshchestva Ispytatelei Prirody, Otd. Biol.
Byulleten Moskovskogo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii *(U.S.S.R.)*

Byul. Nauchn.-Tekhn. Inform. Min. Geol. i Okhrany Nedr SSSR
Byulleten Nauchno-Tekhnicheskoi Informatsii Ministerstva Geologii i Okhrany Nedr SSSR *(U.S.S.R.)*

Byul. Tekhn.-Ekon. Inform., Sov. Nar. Khoz. Ivanovsk. Ekon. Admin. Raiona
Byulleten Tekhniko-Ekonomicheskoi Informatsii, Sovet Narodnogo Khozyaistva Ivanovskogo Ekonomicheskogo Administrativnogo Raiona *(U.S.S.R.)*

Cahiers Phys.
*Cahiers de Physique *(France)*

Calif. Med.
*California Medicine *(U. S.)*

CA, Med. J.
CA, A Medical Journal Published by the American Cancer Society *(U. S.)*

Can. Aeronaut. Space J.
*Canadian Aeronautics and Space Journal *(Canada)*

Cancer
*Cancer *(U. S.)*

Cancer Bull., Texas Ed.
Cancer Bulletin, Texas Edition *(U. S.)*

Cancer Chemotherapy Rept.
*Cancer Chemotherapy Reports *(U. S.)*

Cancer Res.
*Cancer Research *(U. S.)*

Can. Chem. Process.
*Canadian Chemical Processing *(Canada)*

Can. Controls Instr.
Canadian Controls and Instrumentation *(Canada)*

Cancro
Cancro, Il *(Italy)*

Can. Electron. Eng.
Canadian Electronics Engineering *(Canada)*

Can. Geophys. Bull.
*Canadian Geophysical Bulletin *(Canada)*

Can. J. Biochem.
*Canadian Journal of Biochemistry (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

Can. J. Chem.
*Canadian Journal of Chemistry *(Canada)*

Can. J. Chem. Eng.
*Canadian Journal of Chemical Engineering (formerly Canadian Journal of Technology) *(Canada)*

Can. J. Earth Sci.
*Canadian Journal of Earth Sciences *(Canada)*

Can. J. Genet. Cytol.
*Canadian Journal of Genetics and Cytology *(Canada)*

Can. J. Math.
*Canadian Journal of Mathematics *(Canada)*

Can. J. Med. Technol.
*Canadian Journal of Medical Technology, The *(Canada)*

Can. J. Microbiol.
*Canadian Journal of Microbiology *(Canada)*

Can. J. Phys.
*Canadian Journal of Physics *(Canada)*

Can. J. Physiol. Pharmacol.
*Canadian Journal of Physiology and Pharmacology (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

Can. J. Plant Sci.
Canadian Journal of Plant Science *(Canada)*

Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*

Can. J. Public Health
*Canadian Journal of Public Health *(Canada)*

Can. J. Soil Sci.
Canadian Journal of Soil Science *(Canada)*

Can. J. Spectry.
Canadian Journal of Spectroscopy *(Canada)*

Can. J. Surg.
Canadian Journal of Surgery *(Canada)*

Can. J. Zool.
*Canadian Journal of Zoology *(Canada)*

Can. Math. Bull.
*Canadian Mathematical Bulletin *(Canada)*

Can. Med. Assoc. J.
*Canadian Medical Association Journal, The *(Canada)*

Can. Met. Quart.
*Canadian Metallurgical Quarterly *(Canada)*

Can. Mining J.
*Canadian Mining Journal *(Canada)*

Can. Mining Met. Bull.
Canadian Mining and Metallurgical Bulletin, The *(Canada)*

Can. Nucl. Technol.
*Canadian Nuclear Technology *(Canada)*

Can. Patent Office Record
*Canadian Patent Office Record *(Canada)*

Can. Power Engr.
*Canadian Power Engineer *(Canada)*

Can. Serv. Med. J.
*Canadian Services Medical Journal *(Canada)*

Can. Spectry.
*Canadian Spectroscopy *(Canada)*

Carbon
*Carbon *(England)*

Cardiologia
*Cardiologia *(Switzerland)*

Caryologia
*Caryologia *(Italy)*

Casopis Lekaru Ceskych
Casopis Lekaru Ceskych *(Czechslovakia)*

Cellule Rec. Cytol. Histol.
Cellule Recueil de Cytologie et d'Histologie, La *(Belgium)*

Cement-Wapno-Gips
Cement-Wapno-Gips *(Poland)*

Central African J. Med.
Central African Journal of Medicine, The *(Southern Rhodesia)*

Ceram. Age
Ceramic Age *(U. S.)*

Ceram. Ind.
Ceramic Industry *(U. S.)*

Cereal Sci. Today
Cereal Science Today *(U. S.)*

CERN Courier
*CERN Courier *(Switzerland)*

Cesk. Casopis Fys.
*Ceskoslovensky Casopis pro Fysiku *(Czechoslovakia)*

Cesk. Fysiol.
Ceskoslovenska Fysiologie *(Czechoslovakia)*

Cesk. Gastroenterol. Vyziva
Ceskoslovenska Gastroenterologie a Vyziva, Sbornik pro Pathofysiologii Traveni a Vyzivy *(Czechoslovakia)*

Cesk. Hyg.
Ceskoslovenska Hygiena *(Czechoslovakia)*

Cesk. Morfol.
Ceskoslovenska Morfologie *(Czechoslovakia)*

Cesk. Ofthalmol.
Ceskoslovenska Ofthalmologie *(Czechoslovakia)*

Cesk. Radiol.
Ceskoslovenska Radiologie (formerly Ceskoslovenska Rentgenologie) *(Czechoslovakia)*

Cesk. Stomatol.
Ceskoslovenska Stomatologie *(Czechoslovakia)*

Chem. Anal. (Warsaw)
*Chemia Analityczna (Warsaw) *(Poland)*

Chem. Ber.
Chemische Berichte *(Germany)*

Chem. Brit.
*Chemistry in Britain *(England)*

Chem. Bull. (Peking)
Chemical Bulletin (Peking)
see *Hua Hsueh Tung Pao*

Chem. Can.
*Chemistry in Canada *(Canada)*

Chem. Chem. Ind. (Japan)
Chemistry and Chemical Industry (Japan)
see *Kagaku to Kogyo (Tokyo)*

Chem. Commun.
*Chemical Communications *(England)*

Chem. Eng.
Chemical Engineering with Chemical & Metallurgical Engineering *(U. S.)*

Chem. Eng. (Japan)
Chemical Engineering (Japan)
see *Kagaku Kogaku*

Chem. Eng. Progr.
*Chemical Engineering Progress *(U. S.)*

Chem. Eng. Progr., Symp. Ser.
Chemical Engineering Progress, Symposium Series *(U. S.)*

Chem. Eng. Sci.
*Chemical Engineering Science *(U. S.)*

Chem. High Polymers (Tokyo)
Chemistry of High Polymers (Tokyo)
see *Kobunshi Kagaku*

Chemiker Ztg.
Chemiker Zeitung *(Germany)*

Chem. Ind. (London)
*Chemistry & Industry (London) *(England)*

Chem. Ind. (Tokyo)
Chemical Industry (Tokyo)
see *Kagaku Kogyo*

Chem.-Ingr.-Tech.
*Chemie-Ingenieur-Technik *(Germany)*

Chemist-Analyst
*Chemist-Analyst, The *(U. S.)*

Chemistry
Chemistry *(U. S.)*

Chemistry (Kyoto)
Chemistry (Kyoto)
see *Kagaku (Kyoto)*

Chemistry (Taipei)
Chemistry (Taipei)
see *Hua Hsueh*

Chem. Listy
*Chemicke Listy *(Czechoslovakia)*

Chemotherapia
Chemotherapia *(Switzerland)*

Chem. Pharm. Bull. (Tokyo)
Chemical and Pharmaceutical Bulletin (Tokyo) *(Japan)*

Chem. Process Eng.
*Chemical & Process Engineering (including Atomic World) *(England)*

Chem. Prumysl
Chemicky Prumysl *(Czechoslovakia)*

Chem. Rev.
*Chemical Reviews *(U. S.)*

Chem. Stosowana, Ser. A.
*Chemia Stosowana, Seria A *(Poland)*

Chem. Stosowana, Ser. B
*Chemia Stosowana, Seria B *(Poland)*

Chem. Tech. (Berlin)
Chemische Technik, Die (Berlin) *(Germany)*
[Contains a section entitled Glasapparatetechnik, Technisch-wissenschaftliche Beilage der Zeitschrift Chemische Technik (Berlin), which has its own entry]

Chem. Tech. (Leipzig)
*Chemische Technik, VEB Deutscher Verlag fuer Grundstoffindustrie, Leipzig *(Germany)*

Chem. Weekblad
Chemische Weekblad *(Netherlands)*

Chem. World (Shanghai)
Chemical World (Shanghai)
see *Hua Hsueh Shih Chieh*

Chem. Zvesti
Chemicke Zvesti *(Czechoslovakia)*

Chih Wu Hsueh Pao
Chih Wu Hsueh Pao (Acta Botanica Sinica) *(China)*

Chijiki Kansokujo Yoho
Chijiki Kansokujo Yoho (Memoirs of the Kakioka Magnetic Observatory *(Japan)*

Chim. Anal.
*Chimie Analytique (Paris) *(France)*

Chimia (Aarau)
*Chimia (Aarau) *(Switzerland)*

Chim. Ind. (Milan)
Chimica, La, e l'Industria (Milan) *(Italy)*

Chinese J. Phys. (Taiwan)
*Chinese Journal of Physics (Taiwan) *(China)*

Chinese Med. J.
Chinese Medical Journal, The *(China)*

Chin Shu Hsueh Pao
Chin Shu Hsueh Pao (Acta Metallurgica Sinica) *(China)*

Chir. Praxis
Chirurgische Praxis. Zeitschrift fuer die Gesamte Chirurgie *(Austria)*

Chirurg
Chirurg, Der *(Germany)*

Chosun Kwahakwon Tongbo
Chosun Kwahakwon Tongbo (Bulletin of the Korean Academy of Science) *(Korea)*

Chromatog. Rev.
*Chromatographic Reviews *(U. S.)*

Chromosoma
Chromosoma *(Germany)*

Chung Kuo K'o Hsueh
Chung Kuo K'o Hsueh
see *Sci. Sinica (Peking)*

CICIG (Comm. Ital. Comit. Intern. Geofis.), Pubbl., IGC (Intern. Geophys. Comm.)
CICIG (Commissione Italiana del Comitato Internazionale di Geofisica), Pubblicazioni, Serie IGC (International Geophysical Committee) *(Italy)*

Ciencia Interam.
Ciencia Interamericana *(U. S.)*

Ciencia Invest. (Buenos Aires)
Ciencia e Investigacion (Buenos Aires) *(Argentina)*

Ciencias (Madrid)
Ciencias (Madrid), Las *(Spain)*

Cir. Cirujanos
*Cirurgia y Cirujanos *(Mexico)*

Circulation
Circulation *(U. S.)*

Circulation Res.
Circulation Research *(U. S.)*

Cir. Gincol. Urol.
*Cirugia, Ginecologia, y Urologia *(Spain)*

Clin. All-round (Osaka)
Clinics All-round (Osaka)
see *Sogo Rinsho*

Clin. Chem.
*Clinical Chemistry *(U. S.)*
Clin. Chim. Acta
*Clinica Chimica Acta *(Netherlands)*
Clin. Ginecol.
Clinica Ginecologica *(Italy)*
Clin. Med.
Clinical Medicine *(U. S.)*
Clin. Neurosurg.
Clinical Neurosurgery *(U. S.)*
Clin. Obstet. Gynecol.
Clinical Obstetrics and Gynecology *(U. S.)*
Clin. Pediatr. (Philadelphia)
Clinical Pediatrics (Philadelphia) *(U. S.)*
Clin. Proc. Children's Hosp.
Clinical Proceedings of the Children's Hospital *(U. S.)*
Clin. Radiol.
Clinical Radiology *(Scotland)*
Clin. Radiol. (Japan)
Clinical Radiology (Japan)
see Rinsho Hoshasen
Clin. Sci.
Clinical Science *(England)*
Clujul Med.
Clujul Medical *(Romania)*
Cold Spring Harbor Symp. Quant. Biol.
Cold Spring Harbor Symposia on Quantitative Biology *(U. S.)*
Collection Czech. Chem. Commun.
*Collection of Czechoslovak Chemical Communications *(Czechoslovakia)*
Colloq. Met., 7e, Centre Etudes Nucl. Saclay, (Gif-sur-Yvette, France), 1963
Colloque de Metallurgie, Ecrouissage, Restauration, Recristallisation, 7e [Colloque], Centre d'Etudes Nucleaires de Saclay, (Gif-sur-Yvette, France), June 27-28, 1963 (Pub. 1963) *(France)*
Comit. Nazl. Energia Nucl., Notiziario
*Comitato Nazionale per l'Energia Nucleare, Notiziario *(Italy)*
Commun. ACM (Assoc. Computing Machinery)
*Communications of the ACM (Association for Computing Machinery) *(U. S.)*
Communist Chinese Sci. Abstr.
*Communist Chinese Scientific Abstracts *(U. S.)*
Commun. Math. Phys.
Communications in Mathematical Physics *(Germany)*
Commun. Pure Appl. Math.
*Communications on Pure and Applied Mathematics *(U. S.)*
Compt. Rend.
*Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences *(France)*
Compt. Rend. Acad. Agr. France
Comptes Rendus des Seances de l'Academie d'Agriculture de France *(France)*
Compt. Rend. Acad. Bulgare Sci.
Comptes Rendus de l'Academie Bulgare des Sciences *(Bulgaria)*
Compt. Rend. Rech. (Inst. Encour. Rech. Sci. Ind. Agr.)
*Comptes Redus de Recherches (Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture) *(Belgium)*
Compt. Rend. Soc. Biol.
*Comptes Rendus des Seances de la Societe de Biologie et de ses Filiales *(France)*
Compt. Rend. Soc. Franc. Gynecol.
*Comptes Rendus de la Societe Francaise de Gynecologie *(France)*
Comun. Acad. Rep. Populare Romine
Comunicarile Academiei Republicii Populare Romine *(Romania)*
Concours Med.
Concours Medical *(France)*
Conn. Med.
Connecticut Medicine *(U. S.)*
Consulting Engr. (London)
Consulting Engineer, The *(England)*
Contemp. Phys.
*Contemporary Physics *(England)*
Contrib. Boyce Thompson Inst.
Contributions from Boyce Thompson Institute *(U. S.)*
Control
Control *(England)*
Control Eng.
Control Engineering *(U. S.)*
Copeia
Copeia *(U.S.)*
Cornell Vet.
Cornell Veterinarian, The *(U.S.)*
Corrosion
*Corrosion *(U. S.)*
Corrosion Anti-Corrosion
*Corrosion et Anti-Corrosion *(France)*
Corrosion Sci.
*Corrosion Science *(U. S.)*
Corrosion Technol.
Corrosion Technology *(England)*
Croat. Chem. Acta
*Croatica Chemica Acta *(Yugoslavia)*
Crop Sci.
Crop Science *(U. S.)*
Cryobiology
Cryobiology *(U. S.)*
Cryogenics
*Cryogenics *(England)*
Current Sci. (India)
*Current Science *(India)*
Current Therap. Res.
Current Therapeutic Research, Clinical and Experimental *(U. S.)*
Cytogenetics
*Cytogenetics *(Switzerland)*
Czech. Heavy Ind.
Czechoslovak Heavy Industry *(Czechoslovakia)*
Czech. J. Phys.
*Czechoslovak Journal of Physics *(Czechoslovakia)*
Daedalus
Daedalus *(U. S.)*
Danish Med. Bull.
*Danish Medical Bulletin *(Denmark)*
Dansk Kemi
Dansk Kemi *(Denmark)*
Dechema Monograph.
Dechema Monographien *(Germany)*
Delaware Med. J.
Delaware Medical Journal *(U. S.)*
Denki Gakkai Zasshi
Denki Gakkai Zasshi (The Journal of the Institute of Electric Engineers of Japan) *(Japan)*
Denki Kagaku
Denki Kagaku (Journal of the Electrochemical Society of Japan) *(Japan)*
Denki Shikensho Iho
*Denki Shikensho Iho (Bulletin of the Electrotechnical Laboratory (Tokyo)) *(Japan)*
Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku
Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku (Electrical Communication Laboratory, Technical Journal) *(Japan)*
Dermatologica
*Dermatologica *(Switzerland)*
Dermatol. Trop. Ecol. Geograph.
Dermatologia Tropica et Ecologica Geographica *(U. S.)*
Dermatol. Wochschr.
Dermatologische Wochenschrift *(Germany)*
Deut. Gesundheitsw.
Deutsche Gesundheitswesen, Das *(Germany)*
Deut. Lebensm.-Rundschau
Deutsche Lebensmittel-Rundschau *(Germany)*
Deut. Med. Wochschr.
Deutsche Medizinische Wochenschrift *(Germany)*
Deut. Stomatol.
Deutsche Stomatologie *(Germany)*
Deut. Z. Ges. Gerichtl. Med.
Deutsche Zeitschrift fuer die Gesamte Gerichtliche Medizin *(Germany)*
Deut. Z. Verdauungs- Stoffwechselkrankh.
*Deutsche Zeitschrift fuer Verdauungs-und Stoffwechselkrankheiten *(Germany)*
Develop. Appl. Spectry.
Developments in Applied Spectroscopy *(U. S.)*
Develop. Biol.
*Developmental Biology *(U. S.)*
Develop. Med. Child Neurol.
Developmental Medicine and Child Neurology *(England)*

Diabetes
Diabetes *(U. S.)*

Discovery
*Discovery *(England)*

Discussions Faraday Soc.
*Discussions of the Faraday Society *(England)*

Diseases Chest
Diseases of the Chest *(U. S.)*

Diseases Colon Rectum
Diseases of the Colon and Rectum *(U. S.)*

Dissertation Abstr.
*Dissertation Abstracts *(U. S.)*

Dobutsugaku Zasshi
Dobutsugaku Zasshi (The Zoological Magazine) *(Japan)*

Doitai To Hoshasen
Doitai To Hoshasen (Isotopes and Radiation) *(Japan)*

Dokl. Akad. Nauk Arm. SSR
*Doklady Akademii Nauk Armyanskoi SSR *(Armenian S.S.R.)*

Dokl. Akad. Nauk Belorussk. SSR
Doklady Akademii Nauk Belorusskoi SSR *(Belorussian S.S.R.)*

Dokl. Akad. Nauk BSSR
*Doklady Akademii Nauk BSSR (formerly Doklady Akademii Nauk Belorusskoi SSR) *(Belorussian S.S.R.)*

Dokl. Akad. Nauk SSSR
*Doklady Akademii Nauk SSSR† *(U.S.S.R.)*

Dokl. Akad. Nauk Tadzh. SSR
Doklady Akademii Nauk Tadzhikskoi SSR *(Tadzhik S.S.R.)*

Dokl. Bolgar. Akad. Nauk
Doklady Bolgarskoi Akademii Nauk
see Compt. Rend. Acad. Bulgare Sci.

Dokl. i Soobshch. Uzhgorodsk. Gos. Univ., Ser. Fiz. Mat. Nauk
Doklady i Soobshcheniya Uzhgorodskogo Gosudarstvennogo Universiteta, Seriya Fiziko-Matematicheskikh Nauk *(Ukrainian S.S.R.)*

Dopovidi Akad. Nauk Ukr. RSR
*Dopovidi Akademii Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*

Drevar. Vyskum
Drevarsky Vyskum *(Czechoslovakia)*

Duodecim
Duodecim *(Finland)*

"Easa" (J. Engrs.' Assoc. (S. Africa))
"Easa" (The Journal of the Engineers' Association (South Africa)) *(S. Africa)*

East European Sci. Abstr.
*East European Scientific Abstracts *(U. S.)*

Ecol. Monographs
Ecological Monographs *(U. S.)*

Ecology
Ecology *(U. S.)*

Econ. Geol.
*Economic Geology and the Bulletin of the Society of Economic Geologists *(U. S.)*

EEI (Edison Elec. Inst.) Bull.
EEI (Edison Electric Institute) Bulletin *(U. S.)*

Egeszsegtudomany
Egeszsegtudomany *(Hungary)*

Eiyogaku Zasshi
Eiyogaku Zasshi (The Japanese Journal of Nutrition) *(Japan)*

Eiyo To Shokuryo
Eiyo To Shokuryo—Eiyo Shokuryo Gakkaishi (Journal of the Japanese Society of Food and Nutrition) *(Japan)*

Ekol. Polska, Ser. B
*Ekologia Polska, Seria B *(Poland)*

Eksperim. Khirurg. i Anesteziol.
Eksperimental'naya Khirurgia i Anesteziologiya *(U.S.S.R.)*

Eksperim. Med. i Morfol.
Eksperimentalna Meditsina i Morfologiya *(Bulgaria)*

Elec. Commun. Lab. Tech. J.
Electrical Communication Laboratory, Technical Journal
see Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku

Elec. Export Rev.
*Electrical Export Review *(England)*

Elec. Light Power
Electric Light and Power *(U. S.)*

Elec. Rev.
Electrical Review *(England)*

Electricite
*Electricite *(France)*

Electrochem. Technol.
*Electrochemical Technology *(U. S.)*

Electrochim. Acta
*Electrochimica Acta *(U. S.)*

Electron. Design
Electronic Design *(U. S.)*

Electron. Eng.
*Electronic Engineering Incorporating Electronics, Television and Short Wave World *(England)*

Electronics
*Electronics *(U. S.)*

Electronics (Japan)
Electronics (Japan)
see Erekutoronikusu

Electron. Ind.
Electronic Industries *(U. S.)*

Electron. Letters
*Electronics Letters *(England)*

Electron. Power
*Electronics and Power *(England)*

Electron. Record
*Electronics Record *(England)*

Electro-Technol. (N. Y.)
Electro-Technology (New York) *(U. S.)*

Elec. West
Electrical West *(U.S.)*

Elec. World
Electrical World *(U. S.)*

Elektrichestvo
Elektrichestvo† *(U.S.S.R.)*

Elektrie
Elektrie *(Germany)*

Elektromed. Ihre Grenzg.
Elektromedizin und Ihre Grenzgebiete *(Germany)*

Elektron. Bol'shikh Moshchnostei
Elektronika Bol'shikh Moshchnostei *(U.S.S.R.)*

Elektronik
Elektronik *(Germany)*

Elektron. Rundschau
Elektronische Rundschau *(Germany)*

Elektrotech. Casopis
Elektrotechnicky Casopis *(Czechoslovakia)*

Elektrotech. Obzor
Elektrotechniky Obzor *(Czechoslovakia)*

Elektrotech. Z.
Elektrotechnische Zeitschrift *(Germany)*

Elektrotech. Z. A.
Elektrotechnische Zeitschrift. A *(Germany)*

Elektrotekhnika
Elektrotekhnika (formerly Vestnik Elektropromyshlennosti) *(U.S.S.R.)*

Elektrotekhnikeren
Elektroteknikeren *(Denmark)*

Elektr. St.
Elektricheskie Stantsii *(U.S.S.R.)*

Endeavour
*Endeavour *(England)*

Endocrinol. Japon.
Endocrinologia Japonica *(Japan)*

Endocrinology
*Endocrinology *(U. S.)*

Endokrinologie
Endokrinologie *(Germany)*

Endokrynol. Polska
Endokrynologia Polska *(Poland)*

Energetica (Bucharest)
Energetica (Bucharest) *(Romania)*

Energia Atomtech.
*Energia es Atomtechnika *(Hungary)*

Energia Elettrica
Energia Elettrica, L' *(Italy)*

Energia Nucl. (Madrid)
*Energia Nuclear (Madrid) *(Spain)*

Energia Nucl. (Milan)
*Energia Nucleare (Milan) *(Italy)*

Energie Nucl.
*Energie Nucleaire *(France)*

Energy Intern.
*Energy International *(England)*

Engelhard Ind., Tech. Bull.
Engelhard Industries, Inc., Technical Bulletin *(U. S.)*

Engineer
Engineer, The *(England)*

Engineering
Engineering *(England)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. I
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series I *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. II
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series II *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. III
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series III *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. IV
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series IV *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. V
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series V *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. VI
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series VI *(U. S.)*

Eng. Mater. (Tokyo)
Engineering Materials (Tokyo)
see Kogyo Zairyo

Engrs'. Dig.
Engineers' Digest *(England)*

Enka Biniru
Enka Biniru (Vinyl Japan) *(Japan)*

Entomol. Rev. (USSR) (English Transl.)
Entomological Revue (USSR) (English Translation of Entomologicheskoe Obozrenie) *(U. S.)*

Enzymologia
Enzymologia *(Netherlands)*

Epitoanyag
Epitoanyag *(Hungary)*

Erekutoronikusu
Erekutoronikusu (Electronics (Japan)) *(Japan)*

Ergeb. Allgem. Pathol. Pathol. Anat.
*Ergebnisse der Allgemeinen Pathologie und Pathologischen Anatomie *(Germany)*

Ergeb. Exakt. Naturw.
Ergebnisse der Exakten Naturwissenschaften *(Germany)*

Ergeb. Med. Strahlenforsch.
Ergebnisse der Medizinischen Strahlenforschung *(Germany)*

Euphytica
Euphytica *(Netherlands)*

Euratom Bull.
*Euratom Bulletin (Bulletin of the European Atomic Energy Community) *(Netherlands)*

EuroNuclear
*EuroNuclear *(England)*

Evolution Med.
Evolution Medicale, L *(France)*

Excerpta Med. Intern. Congr. Ser.
Excerpta Medica. International Congres Series *(Netherlands)*

Excerpta Med., Sect. XXIII
*Excerpta Medica, Section XXIII *(Netherlands)*

Experientia
*Experientia *(Switzerland)*

Exptl. Cell Res.
*Experimental Cell Research *(U. S.)*

Exptl. Mol. Pathol.
*Experimental and Molecular Pathology *(U. S.)*

Exptl. Neurol.
Experimental Neurology *(U. S.)*

Exptl. Parasitol.
Experimental Parasitology *(U. S.)*

Exptl. Tech. Physik
*Experimentelle Technik der Physik *(Germany)*

FAPIG (Tokyo)
FAPIG (Tokyo) *(Japan)*

Farmaco (Pavia) Ed. Prat.
Farmaco, II (Pavia), Edizione Pratica *(Italy)*

Farmaco (Pavia), Ed. Sci.
Farmaco, II (Pavia), Edizione Scientifica *(Italy)*

Farmakol. i Toksikol.
Farmakologiya i Toksikologiya† *(U.S.S.R.)*

Farm. Obzor
Farmaceuticky Obzor *(Czechoslovakia)*

Faserforsch. Textiltech.
Faserforschung und Textiltechnik *(Germany)*

Federation Proc.
*Federation Proceedings *(U. S.)*

Federation Proc., Transl. Suppl.
*Federation Proceedings, Translation Supplement *(U. S.)*

Fertility Sterility
Fertility and Sterility *(U. S.)*

Fishing News Intern.
Fishing News International *(England)*

Fiz. Atm. i Okeana
Fizika Atmosfery i Okeana *(U.S.S.R.)*

Fiz. Chastits Vysokikh Energii, Akad. Nauk Gruz. SSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*

Fiziol. Zh., Akad. Nauk Ukr. RSR
*Fiziologichnii Zhurnal, Akademiya Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*

Fiz.-Khim. Mekhan. Materialov
*Fiziko-Khimicheskaya Mekhanika Materialov *(Ukrainian S.S.R.)*

Fiz. Khim. Osnovy Proizv. Stali, Akad. Nauk SSSR, Inst. Met., Tr. 6-oi [Shestoi] Konf., Moscow, 1961
Fiziko-Khimicheskie Osnovy Proizvodstva Stali, Akademiya Nauk SSSR, Institut Metallurgii imeni A. A. Baikova, Trudy 6-oi [i.e. Shestoi] Konferentsii po Fiziko-Khimicheskim Osnovam Proizvodstva Stali, Moscow, June 27–July 1, 1961 (Pub. 1964) *(U.S.S.R.)*

Fiziol. Rast.
Fiziologiya Rastenii, Akademiya Nauk SSSR† *(U.S.S.R.)*

Fiz. Metal. i Metalloved.
*Fizika Metallov i Metallovedeniya, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*

Fiz. Szemle
*Fizikai Szemle *(Hungary)*

Fiz. Tverd. Tela
Fizika Tverdogo Tela† *(U.S.S.R.)*

Foederation Europaeischer Gewaesserschutz, Informationsbl.
Foederation Europaeischer Gewaesserschutz (FEG), Informationsblatt *(Switzerland)*

Folia Biol. (Prague)
*Folia Biologica (Prague) *(Czechoslovakia)*

Folia Biol. (Warsaw)
*Folia Biologica (Warsaw) *(Poland)*

Folia Cardiol.
Folia Cardiologica *(Italy)*

Folia Clin. Intern.
*Folia Clinica Internacional *(Spain)*

Folia Endocrinol. (Rome)
Folia Endocrinologica (Rome) *(Italy)*

Folia Haematol. (Frankfurt)
*Folia Haematologica (Frankfurt) *(Germany)*

Folia Histochem. Cytochem.
Folia Histochemica et Cytochemica *(Poland)*

Folia Med. (Naples)
*Folia Medica (Naples) *(Italy)*

Folia Microbiol. (Prague)
Folia Microbiologica (Prague) *(Czechoslovakia)*

Folia Morphol.
*Folia Morphologica *(Poland)*

Folia Ophthalmol. Japon.
Folia Ophthalmologica Japonica
see Nippon Ganka Kiyo

Food Agr. Organ. U. N., FAO At. Energy Ser.
Food and Agriculture Organization of the United Nations, FAO Atomic Energy Series *(U. S.)*

Food Cosmet. Toxicol.
Food and Cosmetics Toxicology *(England)*

Food Irradiation
*Food Irradiation *(France)*

Food Technol.
Food Technology *(U. S.)*

Forest Sci.
Forest Science *(U. S.)*

Forsch. Gebiete Ingenieurw.
Forschung auf dem Gebiete des Ingenieurwesens *(Germany)*

Fortschr. Chem. Forsch.
*Fortschritte der Chemischen Forschung *(Germany)*

Fortschr. Gebiete Roentgenstrahlen Nuklearmed.
*Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, Diagnostik, Physik, Biologie, Therapie *(Germany)*

Fortschr. Kiefer- Gesichtschir.
Fortschritte der Kiefer- und Gesichtschirurgie *(Germany)*

Fortschr. Physik
*Fortschritte der Physik *(Germany)*

Fortschr. Zool.
Fortschritte der Zoologie *(Germany)*

Fra Fysik. Verden
Fra Fysikkens Verden *(Norway)*

Frankfurter Z. Pathol.
Frankfurter Zeitschrift fuer Pathologie *(Germany)*

Freiberger Forschungsh. B
Freiberger Forschungshefte. Reihe B *(Germany)*

Fruits (Paris)
Fruits (Paris) *(France)*

Fuel
Fuel *(England)*

Fuji Elec. J.
Fuji Electric Journal
see Fuji Jiho

Fuji Jiho
Fuji Jiho (Fuji Electric Journal) *(Japan)*

Fukuoka Acta Med.
Fukuoka Acta Medica
see Fukuoka Igaku Zasshi

Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*

Funtai Oyobi Funmatsuyakin
Funtai Oyobi Funmatsuyakin (Journal of Japan Society of Powder Metallurgy) *(Japan)*

Furitsu Ikadaigaku Zasshi
Furitsu Ikadaigaku Zasshi (Journal of the Kyoto Prefecture Medical University) *(Japan)*

Gac. Ortoped. Traumatol.
*Gaceta Ortopedia y Traumatologia *(Mexico)*

Gamma Field Symp.
Gamma Field Symposia *(Japan)*

Gann
Gann *(Japan)*

Gan no Rinsho
Gan no Rinsho (Japanese Journal of Cancer Clinics) *(Japan)*

Gas-Wasserfach
Gas-Wasserfach, Das *(Germany)*

Gaz. Med. France
Gazette Medicale de France *(France)*

Gaz. Prom.
Gazovaya Promyshlennost *(U.S.S.R.)*

Gazz. Chim. Ital.
Gazzette Chimica Italiana *(Italy)*

Gazz. Intern. Med. Chir.
Gazzetta Internazionale di Medicina e Chirurgia *(Italy)*

Geburtsh. Frauenheilk.
*Geburtshilfe und Frauenheilkunde *(Germany)*

G.E.C.J. Sci. Tech.
*G. E. C. Journal of Science and Technology *(England)*

G.E.N. (Caracas)
*G.E.N. (Caracas) *(Venezuela)*

Gencho Hiroshima Igaku
*Gencho Hiroshima Igaku (The Hiroshima Medical Journal) *(Japan)*

Gen. Comp. Endocrinol.
*General and Comparative Endocrinology *(U. S.)*

Geneesk. Gids
Geneeskundige Gids *(Netherlands)*

Genet. Agrar.
Genetica Agraria *(Italy)*

Genetica
*Genetica *(Netherlands)*

Genetics
*Genetics *(U. S.)*

Genet. Polon.
*Genetica Polonica *(Poland)*

Genet. Res.
*Genetical Research *(England)*

Genet. Slechteni
Genetika a Slechteni *(Czechoslovakia)*

Genie Chim.
Genie Chimique (Supplement mensuel a Chimie & Industrie) *(France)*

Genie Civil
Genie Civil, Le *(France)*

Genshikaku Kenkyu
Genshikaku Kenkyu *(Japan)*

Genshiryoku Chosa Jiho
Genshiryoku Chosa Jiho (Review of Atomic Industries) *(Japan)*

Genshiryoku Hatsuden
Genshiryoku Hatsuden (Nuclear Power) *(Japan)*

Genshiryoku Kogyo
*Genshiryoku Kogyo (Nuclear Engineering) *(Japan)*

Geochim. Cosmochim. Acta
*Geochimica et Cosmochimica Acta *(England)*

Geofiz. Kozlemen.
*Geofizikai Kozlemenyek *(Hungary)*

Geokhimiya
*Geokhimiya† *(U.S.S.R.)*

Geol. Rudn. Mestorozhd.
Geologiya Rudnykh Mestorozhdenii, Akademiya Nauk SSSR *(U.S.S.R.)*

Geol. Rundschau
Geologische Rundschau *(Germany)*

Geol. Soc. Am., Bull.
Geological Society of America, Bulletin *(U. S.)*

Geomagnetism Aeronomy (USSR) (English Transl.)
Geomagnetism and Aeronomy (USSR) (English Translation of Geomagnetizm i Aeronomiya) *(U. S.)*

Geomagnetizm i Aeronomiya
*Geomagnetizm i Aeronomiya† *(U.S.S.R.)*

Geophys. Geol.
Geophysik und Geologie *(Germany)*

Geophysics
*Geophysics *(U. S.)*

Geophys. J.
*Geophysical Journal *(England)*

Geotektonika
*Geotektonika *(U.S.S.R.)*

Geriatrics
Geriatrics *(U. S.)*

German Med. Monthly
German Medical Monthly *(Germany)*

Gerontol. Clin.
*Gerontologia Clinica *(Switzerland)*

Gerontologia
*Gerontologia *(Switzerland)*

Gesundh.-Ingr.
Gesundheits-Ingenieur *(Germany)*

Getreide Mehl
Getreide und Mehl *(Germany)*

Gifu Ika Daigaku Kiyo
Gifu Ika Daigaku Kiyo (Acta Scholae Medicinalis in Gifu) *(Japan)*

Gigiena i Sanit.
*Gigiena i Sanitariya *(U. S. S. R.)*

Gigiena Truda i Prof. Zabolevaniya
Gigiena Truda i Professional'nye Zabolevaniya *(U.S.S.R.)*

Gijutsu Kenkyusho Shoho
Gijutsu Kenkyusho Shoho (Journal of Technical Laboratory (Tokyo)) *(Japan)*

Ginecol. Obstet. Mex.
*Ginecologia y Obstetricia de Mexico *(Mexico)*

Giorn. Gerontol.
*Giornale di Gerontologia *(Italy)*

Giorn. Igiene Med. Prevent.
Giornale di Igiene e Medicina Preventiva *(Italy)*

Giorn. Ital. Chemioterapia
*Giornale Italiano di Chemioterapia *(Italy)*

Giorn. Ital. Chir.
Giornale Italiano di Chirurgia *(Italy)*

Giorn. Med. Mil.
Giornale di Medicina Militare *(Italy)*

Giorn. Microbiol.
*Gironale di Microbiologia *(Italy)*

Glas-Instr.-Tech.
Glas-Instrumenten-Technik *(Germany)*

Glasnik Mat.-Fiz. Astron., Ser. II
*Glasnik Matematicko-Fizicki i Astronomski, Serija II *(Yugoslavia)*

Glass Technol.
Glass Technology *(England)*

Grasas Aceites (Seville, Spain)
Grasas y Aceites (Seville, Spain) *(Spain)*

Growth
Growth *(U. S.)*

Grundforbattring
Grundforbattring *(Sweden)*

Guy's Hosp. Rept.
*Guy's Hospital Reports *(England)*

Gynecol. Obstet.
Gynecologie et Obstetrique *(France)*

Haematologica (Pavia)
Haematologica (Pavia) *(Italy)*

Hautarzt
Hautarzt, Der *(Austria)*

Health Lab. Sci.
Health Laboratory Science *(U. S.)*

Health Phys.
*Health Physics *(U. S.-England)*

Helv. Chim. Acta
*Helvetica Chimica Acta *(Switzerland)*

Helv. Chir. Acta
*Helvetica Chirurgica Acta *(Switzerland)*

Helv. Med. Acta
*Helvetica Medica Acta *(Switzerland)*

Helv. Paediat. Acta
*Helvetica Paediatrica Acta *(Switzerland)*

Helv. Phys. Acta
*Helvetica Physica Acta *(Switzerland)*

Helv. Physiol. Pharmacol. Acta
Helvetica Physiologica et Pharmacologica Acta *(Switzerland)*

Hemera Zoa
Hemera Zoa *(Indonesia)*

Hereditas
*Hereditas *(Sweden)*

Heredity
Heredity *(England)*

High Pressure (Tokyo)
High Pressure (Tokyo) *(Japan)*

High Temp. (USSR) (English Transl.)
High Temperature (USSR) (English Translation of Teplofizika Vysokikh Temperatur) *(U. S.)*

Hi-hakai Kensa
Hi-hakai Kensa (Journal of N.D.I.) *(Japan)*

Hindustan Antibiot. Bull.
*Hindustan Anvibiotics Bulletin *(India)*

Hippokrates (Stuttgart)
Hippokrates (Stuttgart) *(Germany)*

Hirosaki Igaku
*Hirosaki Igaku (The Hirosaki Medical Journal) *(Japan)*

Hirosaki Med. J.
Hirosaki Medical Journal, The
see Hirosaki Igaku

Hiroshima Igaku
Hiroshima Igaku (The Journal of the Hiroshima Medical Association) *(Japan)*

Hiroshima J. Med. Sci.
*Hiroshima Journal of Medical Sciences *(Japan)*

Hiroshima Med. J.
Hiroshima Medical Journal, The
see Gencho Hiroshima Igaku

Hitachi Hyoron
Hitachi Hyoron (Hitachi Review) *(Japan)*

Hitachi Rev.
Hitachi Review
see Hitachi Hyoron

Hitachi Zosen Giho
Hitachi Zosen Giho (The Hitachi Zosen Technical Review) *(Japan)*

Hitachi Zosen Tech. Rev.
Hitachi Zosen Technical Review, The
see Hitachi Zosen Giho

HNO
HNO. Beihefte zur Zeitschrift fuer Hals-, Nasen- und Ohrenheilkunde *(Germany)*

Holz Roh- Werkstoff
Holz als Roh- und Werkstoff *(Germany)*

Hospital (London)
Hospital (London) *(England)*

Hospital (Rio de Janeiro)
Hospital, O (Rio de Janeiro) *(Brazil)*

Hospitals
Hospitals *(U. S.)*

Ho Tsu K'o Hsueh
*Ho Tsu K'o Hsueh (Nuclear Science) *(China)*

Hua Hsueh
Hua Hsueh (Chemistry (Taipei)) *(China)*

Hua Hsueh Hsueh Pao
Hua Hsueh Hsueh Pao (Acta Chimica Sinica) *(China)*

Hua Hsueh Shih Chieh
Hua Hsueh Shih Chieh (Chemical World (Shanghai)) *(China)*

Hua Hseuh Tung Pao
*Hua Hseuh Tung Pao (Chemical Bulletin) *(China)*

Huaxue Tongbao
Huaxue Tongbao
see Hua Hseuh Tung Pao

Hutnicke Listy
Hutnicke Listy *(Czechoslovakia)*

Hydraulics Pneumatics
Hydraulics & Pneumatics *(U. S.)*

Ibaraki Daigaku Nogakubu Gakujitsu Hokoku
Ibaraki Daigaku Nogakubu Gakujitsu Hokoku (Scientific Reports of the Faculty of Agriculture, Ibaraki University) *(Japan)*

Icarus
*Icarus. International Journal of the Solar System *(U.S.-Eng.)*

Ideggyogy. Szemle
Ideggyogyaszati Szemle *(Hungary)*

Idengaku Zasshi
*Idengaku Zasshi (Japanese Journal of Genetics) *(Japan)*

Idojaras
Idojaras *(Hungary)*

IEEE (Inst. Elec. Electron. Engrs.), Spectrum
*IEEE (Institute of Electrical and Electronics Engineers), Spectrum *(U. S.)*

IEEE (Inst. Elec. Electron. Engrs.), Trans. Commun. Technol.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Communication Technology (formerly IEEE (Institute of Electrical and Electronics Engineers), Transactions on Communication and Electronics) *(U. S.)*

IEEE (Inst. Elec. Electron. Engrs.), Trans. Military Electron.
IEEE (Institute of Electrical and Electronics Engineers), Transactions on Military Electronics (formerly IRE (Institute of Radio Engineers), Transactions on Military Electronics) *(U. S.)*

IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Nuclear Science (formerly IRE (Institute of Radio Engineers), Transactions on Nuclear Science) *(U. S.)*

Igaku To Seibutsugaku
Igaku To Seibutsugaku (Medicine and Biology) *(Japan)*

Igiene Mod. (Parma)
Igiene Moderna, L'(Parma) *(Italy)*

Igiene Sanita Pubblica (Rome)
Igiene e Sanita Pubblica (Rome) *(Italy)*

Ikushugaku Zasshi
Ikushugaku Zasshi (Japanese Journal of Breeding) *(Japan)*

Illinois Med. J.
Illinois Medical Journal *(U. S.)*

Immunology
*Immunology *(England)*

Ind. Aliment. Agr. (Paris)
Industries Alimentaires et Agricoles (Paris) *(France)*

Ind. At.
*Industries Atomiques *(France)*

Ind. Electron.
Industrial Electronics incorporating Electronic Technology *(England)*

Ind. Eng. Chem.
*Industrial and Engineering Chemistry *(U. S.)*

Ind. Eng. Chem., Fundamentals
*Industrial & Engineering Chemistry, Fundamentals *(U. S.)*

Ind. Eng. Chem., Process Design Develop.
*Industrial & Engineering Chemistry, Process Design and Development *(U. S.)*

Ind. Eng. Chem., Prod. Res. Develop.
*Industrial & Engineering Chemistry, Product Research and Development *(U. S.)*

Indian Eastern Engr.
*Indian & Eastern Engineer, The (incorporating the Far Eastern Engineer and Indian & Eastern Motors) *(India)*

Indian J. Chem.
*Indian Journal of Chemistry *(India)*

Indian J. Child Health
*Indian Journal of Child Health, The *(India)*

Indian J. Exptl. Biol.
*Indian Journal of Experimental Biology *(India)*

Indian J. Genet. Plant Breeding
Indian Journal of Genetics & Plant Breeding *(India)*

Indian J. Malariol.
Indian Journal of Malariology *(India)*

Indian J. Med. Res.
Indian Journal of Medical Research, The *(India)*

Indian J. Med. Sci.
*Indian Journal of Medical Sciences *(India)*

Indian J. Phys.
*Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science *(India)*

Indian J. Physiol. Pharmacol.
Indian Journal of Physiology and Pharmacology *(India)*

Indian J. Plant Physiol.
Indian Journal of Plant Physiology *(India)*

Indian J. Pure Appl. Phys.
*Indian Journal of Pure & Applied Physics *(India)*

Indian J. Radiol.
*Indian Journal of Radiology *(India)*

Indian J. Technol.
*Indian Journal of Technology (formerly Journal of Scientific and Industrial Research (India), Section D) *(India)*

Indian Sci. Abstr.
*Indian Science Abstracts *(India)*

Ind. Med. Surg.
*Industrial Medicine and Surgery *(U. S.)*

Ind. Prod. Res.
Industrial Production Research
see Seisan-Kenkyu

Ind. Res.
*Industrial Research *(U. S.)*

Ingenieur (Utrecht)
Ingenieur, De (Utrecht) *(Netherlands)*

Ingenioren
Ingenioren *(Denmark)*

Ing. Nucl.
*Ingegneria Nucleare *(Italy)*

Ingrs. Techniciens
Ingenieurs et Techniciens; Revue Mensuelle des Progres Techniques dans l'Industrie *(France)*

Inorg. Chem.
*Inorganic Chemistry *(U. S.)*

Instr. Control Systems
Instruments and Control Systems *(U. S.)*

Instr. Nucl. (Paris)
*Instrumentation Nucleaire (Paris). Supplement au Bulletin d'Informations Scientifiques et Techniques (Paris) *(France)*

Instr. Pract.
Instrument Practice *(England)*

Intern. Advan. Cryog. Eng.
International Advances in Cryogenic Engineering *(U. S.)*

Intern. Aerospace Abstr.
*International Aerospace Abstracts *(U. S.)*

Internal Med. (Tokyo)
Internal Medicine (Tokyo)
see Naika

Intern. Arch. Allergy Appl. Immunol.
*International Archives of Allergy and Applied Immunology *(Switzerland)*

Intern. Arch. Gewerbepathol. Gewerbehyg.
Internationales Archiv fuer Gewerbepathologie und Gewerbehygiene *(Germany)*

Intern. At. Energy Agency Bull.
*International Atomic Energy Agency Bulletin *(Austria)*

Intern. Chem. Eng.
International Chemical Engineering *(U. S.)*

Intern. Dental J.
International Dental Journal *(Netherlands)*

Internist
Internist, Der *(Germany)*

Intern. J. Air Water Pollution
*International Journal of Air & Water Pollution (formerly International Journal of Air Pollution) *(England)*

Intern. J. Appl. Radiation Isotopes
*International Journal of Applied Radiation and Isotopes *(England)*

Intern. J. Electron.
*International Journal of Electronics (formerly Journal of Electronics and Control) *(England)*

Intern. J. Heat Mass Transfer
*International Journal of Heat and Mass Transfer *(England)*

Intern. J. Leprosy
International Journal of Leprosy *(U. S.)*

Intern. J. Mech. Sci.
International Journal of Mechanical Sciences *(England)*

Intern. J. Neurol.
International Journal of Neurology *(Uruguay)*

Intern. J. Powder Met.
*International Journal of Powder Metallurgy *(U. S.)*

Intern. J. Radiation Biol.
*International Journal of Radiation Biology and related studies in Physics, Chemistry and Medicine *(England)*

Intern. Nursing Rev.
International Nursing Review *(England)*

Intern. Opthalmol. Clin.
International Ophthalmology Clinics *(U. S.)*

Intern. Rev. Cytol.
International Review of Cytology *(U. S.)*

Intern. Rev. Exptl. Pathol.
International Review of Experimental Pathology *(England)*

Intern. Sci. Technol.
*International Science and Technology *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. I
*International Series of Monographs on Nuclear Energy, Division I. Economics and Law *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. II
*International Series of Monographs on Nuclear Energy, Division II. Nuclear Physics *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. III
*International Series of Monographs on Nuclear Energy, Division III. Biology *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. IV
*International Series of Monographs on Nuclear Energy, Division IV. Isotopes and Radiation *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. V
*International Series of Monographs on Nuclear Energy, Division V. Health Physics *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. VI
*International Series of Monographs on Nuclear Energy, Division VI. Medicine *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. VII
*International Series of Monographs on Nuclear Energy, Division VII. Reactor Engineering *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. VIII
*International Series of Monographs on Nuclear Energy, Division VIII. Materials *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. IX
*International Series of Monographs on Nuclear Energy, Division IX. Chemical Engineering *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. X
*International Series of Monographs on Nuclear Energy, Division X. Reactor Design Physics *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. XI
*International Series of Monographs on Nuclear Energy, Division XI. Reactor Operational Problems *(U. S.)*

Intern. Ser. Monographs Nucl. Energy, Div. XIV
*International Series of Monographs on Nuclear Energy, Division XIV. Plasma Physics and Thermonuclear Research *(U. S.)*

Intern. Union Geodesy Geophys. Monograph
International Union of Geodesy and Geophysics Monograph *(France)*

Invest. Ophthalmol.
Investigative Ophthalmology *(U. S.)*

Invest. Urol.
Investigative Urology *(U. S.)*

Inzh.-Fiz. Zh.
*Inzhenerno-Fizicheskii Zhurnal (formerly Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR) *(Belorussian S.S.R.)*

Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR
Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR *(Belorussian S.S.R.)*

ISA (Instr. Soc. Am.) Trans.
*ISA (Instrument Society of America) Transactions *(U. S.)*

Ishikawajima-Harima Eng. Rev.
Ishikawajima-Harima Engineering Review
see Ishikawajima-Harima Giho

Ishikawajima-Harima Giho
Ishikawajima-Harima Giho (Ishikawajima-Harima Engineering Review) *(Japan)*

Isotopes Radiation (Tokyo)
Isotopes and Radiation (Tokyo)
see Doitai To Hoshasen

Isotopes Radiation Technol.
*Isotopes and Radiation Technology (A Quarterly Technical Progress Review) *(U. S.)*

Israel J. Chem.
*Israel Journal of Chemistry (supersedes Bulletin of the Research Council of Israel, Section A: Chemistry) *(Israel)*

Israel J. Exptl. Med.
Israel Journal of Experimental Medicine (formerly Bulletin of the Research Council of Israel, Section E) *(Israel)*

Israel J. Phys.
*Israel Journal of Physics (supersedes in part Bulletin of the Research Council of Israel, Section F: Mathematics and Physics) *(Israel)*

Issled. po Fiz. Atm., Akad. Nauk Estonsk. SSR
*Issledovaniya po Fizike Atmosfery, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*

Issled. po Zharoprock. Splavam, Akad. Nauk SSSR, Inst. Met.
*Issledovaniya po Zharoprochnym Splavam, Akademiya Nauk SSSR, Institut Metallurgii imeni A. A. Baikova *(U.S.S.R.)*

Istanbul Tek. Univ. Bul.
*Istanbul Teknik Universitesi Bulteni *(Turkey)*

Istanbul Univ. Fen Fak. Mecmuasi, Seri A
*Istanbul Universitesi Fen Fakultesi Mecmuasi, Seri A *(Turkey)*

Istanbul Univ., Fen Fak. Mecmuasi, Seri C
*Istanbul Universitesi Fen Fakultesi Mecmuasi: Seri C: Astronomi-Fizik-Kimya *(Turkey)*

Ital. Agr.
L'Italia Agricola *(Italy)*

IVA (Ingeniorsvetenskapsakad.) Medd.
IVA (Ingeniorsvetenskapsakademien) Meddelande *(Sweden)*

Iwate Daigaku Nogakubu Hokoku
Iwate Daigaku Nogakubu Hokoku (Journal of the Faculty of Agriculture, Iwate University) *(Japan)*

Iwate Igaku Zasshi
Iwate Igaku Zasshi (The Journal of the Iwate Medical Association) *(Japan)*

Izmeritel. Tekhn.
*Izmeritel'naya Tekhnika' *(U.S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Biol. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Nauk Zemle
*Izvestiya Akademii Nauk Armyanskoi SSR, Nauk o Zemle *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*

Izv. Akad. Nauk Azerb. SSR, Ser. Biol. i Med. Nauk
Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Biologicheskikh i Meditsinskikh Nauk *(Azerbaidzhan S.S.R.)*

Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekhn. i Mat. Nauk
*Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Tekhnicheskikh i Matematicheskikh Nauk (formerly Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk) *(Azerbaidzhan S.S.R.)*

Izv. Akad. Nauk Est. SSR, Ser. Biol.
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Biologicheskaya *(Estonian S.S.R.)*

Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. i Tekhn. Nauk
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Estonskoi SSR, Seriya Tekhnicheskikh i Fiziko Matematicheskikh Nauk) *(Estonian S.S.R.)*

Izv. Akad. Nauk Kaz. SSR, Ser. Biol. Nauk
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Biologicheskikh Nauk (supersedes Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Botaniki i Pochvovedeniya) *(Kazakh S.S.R.)*

Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Kazakh S.S.R.)*

Izv. Akad. Nauk SSSR, Energ. i Transp.
*Izvestiya Akademii Nauk SSSR, Energetika i Transport (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Energetika i Transport) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Fiz. Atm. i Okeana
*Izvestiya Akademii Nauk SSSR, Fizika Atmosfery i Okeana (supersedes in part Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskiya) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Fiz. Zemli
*Izvestiya Akademii Nauk SSSR, Fizika Zemli (supersedes in part Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskiya) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Mekhan.
*Izvestiya Akademii Nauk SSSR, Mekhanika (formerly Izvestiya Akademii Nauk SSSR, Mekhanika i Mashinostroenie) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Metal.
*Izvestiya Akademii Nauk SSSR, Metally (formerly Izvestiya Akademii Nauk SSSR, Metallurgiya i Gornoe Delo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Met. i Gorn. Delo
Izvestiya Akademii Nauk SSSR, Metallurgiya i Gornoe Delo (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metallurgiya i Gornoe Delo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Neorgan. Materialy
Izvestiya Akademii Nauk SSSR, Neorganicheskie Materialy *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Biol.
*Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Fiz.
*Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geofiz.
Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Khim.
*Izvestiya Akademii Nauk SSSR, Seriya Khimicheskaya (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Khimicheskikh Nauk) *(U.S.S.R.)*

Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Uzbek S.S.R.)*

Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk.
*Izvestiya na Fizicheskiya Institut s Aneb, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Geofiz. Inst., Bulgar. Akad. Nauk.
Izvestiya na Geofizichniya Institut, Bulgarska Akademiya na Naukite, Otdelenie za Matematicheski i Fizicheski Nauki *(Bulgaria)*

Izv. Gl. Astron. Observ. Pulkovo
Izvestiya Glavnoi Astronomicheskoi Observatorii v Pulkovo *(U.S.S.R.)*

Izv. Ges. Nauchn.-Issled. Inst. Ozern. i Rechn. Rybn. Khoz.
Izvestiya Gosudarstvennogo Nauchno-Issledovatel'skogo Instituta Ozernogo i Rechnogo Rybnogo Khozyaistva *(U.S.S.R.)*

Izv. Inst. Fizikokhim., Bulgar. Akad. Nauk.
Izvestiya na Instituta po Fizikokhimiya, Bulgarska Akademiya na Naukite, Otdelenie za Geologicheski, Geografski i Khimicheski Nauki *(Bulgaria)*

Izv. Inst. po Fiziol. Bulgar. Akad. Nauk.
Izvestiya na Instituta po Fiziologia, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Krymsk. Astrofiz. Observ.
Izvestiya Krymskoi Astrofizicheskoi Observatorii *(U.S.S.R.)*

Izv. Sektora Fiz.-Khim. Analiza, Inst. Obshch. Neorgan. Khim., Akad. Nauk SSSR
Izvestiya Sektora Fiziko-Khimicheskogo Analiza, Institut Obshchei i Neorganicheskoi Khimii imeni N. S. Kurnakova, Akademiya Nauk SSSR *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Biologo-Meditsinskikh Nauk *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Khimicheskikh Nauk *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Tekhn. Nauk.
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Tekhnicheskikh Nauk (supersedes in part Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR) *(U.S.S.R.)*

Izv. Timiryazev. Sel'skokhoz. Akad.
Izvestiya Timiryazevskoi Sel'skokhozyaistvennoi Akademii *(U.S.S.R.)*

Izv. Tomsk. Politekhn. Inst.
Izvestiya Tomskogo Politekhnicheskogo Instituta imeni S. M. Kirova *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Chernaya Met.
Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metallurgiya *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Energ.
Izvestiya Vysshikh Uchebnykh Zavedenii, Energetika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Fiz.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Fizika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol.
Izvestiya Vysshikh Uchebnykh Zavedenii, Khimiya i Khimicheskaya Tekhnologiya *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Mat.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Radiofiz.
*Izvestiya Vysshikh Uchebnykh Zavednii, Radiofizika† *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met.
*Izvestiya Vysshikh Uchebnykh Zavednii, Tsvetnaya Metallurgiya *(U.S.S.R.)*

J. Acoust. Soc. Am.
Journal of the Acoustical Society of America, The *(U. S.)*

Jaderna Energie
*Jaderna Energie *(Czechoslovakia)*

J. Agr. Chem. Soc. Japan
Journal of the Agricultural Chemical Society of Japan
see Nippon Nogeikagaku Kaishi

J. Agr. Food Chem.
Journal of Agricultural and Food Chemistry *(U. S.)*

J. Agr. Sci.
Journal of Agricultural Science, The *(England)*

Jahresber. Dout. Wetterdienstes
*Jahresberichte des Deutschen Wetterdienstes *(Germany)*

J. Albert Einstein Med. Center
Journal of the Albert Einstein Medical Center *(U. S.)*

J. Allergy
Journal of Allergy, The *(U.S.)*

J. Am. Ceram. Soc.
*Journal of the American Ceramic Society *(U. S.)*

J. Am. Chem. Soc.
*Journal of the American Chemical Society *(U. S.)*

J. Am. Dental Assoc.
Journal of the American Dental Association, The *(U. S.)*

J. Am. Dietet. Assoc.
Journal of the American Dietetic Association *(U. S.)*

J. Am. Geriat. Soc.
Journal of the American Geriatrics Society *(U. S.)*

J. Am. Med. Assoc.
Journal of the American Medical Association, The *(U. S.)*

J. Am. Med. Women's Assoc.
Journal of the American Medical Women's Association *(U. S.)*

J. Am. Oil Chemists' Soc.
Journal of the American Oil Chemists' Society, The *(U. S.)*

J. Am. Osteopath. Assoc.
Journal of the American Osteopathic Association, The *(U. S.)*

J. Am. Pharm. Assoc.
Journal of the American Pharmaceutical Association *(U. S.)*

J. Am. Vet. Med. Assoc.
Journal of the American Veterinary Medical Association *(U. S.)*

J. Am. Water Works Assoc.
*Journal of the American Water Works Association *(U. S.)*

J. Animal Sci.
Journal of Animal Science *(U. S.)*

Japan Analyst
Japan Analyst
see Bunseki Kagaku

Japan. Arch. Internal Med.
Japanese Archives of Internal Medicine
see Naika Hokan

Japan. Circulation J. (English Ed.)
*Japanese Circulation Journal (English Edition) *(Japan)*

Japan. Heart J.
*Japanese Heart Journal *(Japan)*

Japan. J. Appl. Phys.
*Japanese Journal of Applied Physics *(Japan)*

Japan. J. Breeding
Japanese Journal of Breeding
see Ikushugaku Zasshi

Japan. J. Cancer Clin.
Japanese Journal of Cancer Clinics
see Gan no Rinsho

Japan. J. Chest Diseases
Japanese Journal of Chest Diseases, The
see Nippon Kyobu Rinsho

Japan. J. Clin. Hematol.
Japanese Journal of Clinical Hematology, The
see Rinsho Ketsueki

Japan. J. Genetics
Japanese Journal of Genetics
see Idengaku Zasshi

Japan. J. Human Genet.
Japanese Journal of Human Genetics
see Jinrui Idengaku Zasshi

Japan. J. Hyg.
Japanese Journal of Hygiene
see Nippon Eisaigaku Zasshi

Japan. J. Med.
Japanese Journal of Medicine *(Japan)*

Japan J. Microbiol.
Japanese Journal of Microbiology *(Japan)*

Japan. J. Nutr.
Japanese Journal of Nutrition, The
see Eiyogaku Zasshi

Japan. J. Physiol.
Japanese Journal of Physiology, The *(Japan)*

Japan. J. Public Health
Japanese Journal of Public Health
see Nippon Kosbu Eisei Zasshi

Japan. J. Tuberc.
Japanese Journal of Tuberculosis, The *(Japan)*

Japan. J. Urol.
Japanese Journal of Urology
see Nippon Hinyokika Gakkai Zasshi

Japan. J. Vet. Sci.
Japanese Journal of Veterinary Science
see Nippon Juigaku Zasshi

Japan Steel Works Tech. Rev.
Japan Steel Works Technical Review
see Nippon Seiko Giho

J. Appl. Bacteriol.
Journal of Applied Bacteriology, The *(England)*

J. Appl. Chem. (London)
*Journal of Applied Chemistry (London) *(England)*

J. Appl. Mech.
*Journal of Applied Mechanics, Transactions of the ASME, Series E *(U. S.)*

J. Appl. Meteorol.
*Journal of Applied Meteorology *(U. S.)*

J. Appl. Phys.
*Journal of Applied Physics *(U. S.)*

J. Appl. Physiol.
Journal of Applied Physiology *(U. S.)*

J. Appl. Polymer Sci.
*Journal of Applied Polymer Science *(U. S.)*

J. Arkansas Med. Soc.
Journal of the Arkansas Medical Society, The *(U. S.)*

J. Assoc. Offic. Agr. Chemists
*Journal of the Association of Official Agricultural Chemists *(U. S.)*

J. Assoc. Physicians India
Journal of the Association of the Physicians of India *(India)*

J. At. Energ. Soc. Japan
Journal of the Atomic Energy Society of Japan
see Nippon Genshiryoku Gakkaishi

J. Atherosclerosis Res.
Journal of Atherosclerosis Research *(Netherlands)*

J. Atmospheric Sci.
*Journal of the Atmospheric Sciences (formerly the Journal of Meteorology) *(U. S.)*

J. Atmospheric Terrest. Phys.
*Journal of Atmospheric and Terrestrial Physics *(U. S.)*

J. Australian Inst. Metals
*Journal of the Australian Institute of Metals *(Australia)*

J. Bacteriol.
*Journal of Bacteriology *(U. S.)*

J. Basic Eng.
*Journal of Basic Engineering, Transactions of the ASME, Series D *(U. S.)*

J. Belge Radiol.
*Journal Belge de Radiologie *(Belgium)*

J. Biochem. (Tokyo)
Journal of Biochemistry, The (Tokyo) *(Japan)*

J. Biol. Chem.
*Journal of Biological Chemistry, The *(U. S.)*

J. Bone Joint Surg.
Journal of Bone and Joint Surgery, The *(U. S.)*

J. Brasil. Neurol.
*Journal Brasileiro de Neurologia *(Brazil)*

J. Brasil. Psiquiat.
*Journal Brasileiro de Psiquiatria *(Brazil)*

J. Brit. Interplanet. Soc.
*Journal of the British Interplanetary Society *(England)*

J. Brit. Nucl. Energy Soc.
*Journal of the British Nuclear Energy Society, The (formerly Journal of the British Nuclear Energy Conference) *(England)*

J. Calif. State Dental Assoc.
Journal of the California State Dental Association, The *(U. S.)*

J. Can. Assoc. Radiologists
*Journal of the Canadian Association of Radiologists *(Canada)*

J. Can. Ceram. Soc.
*Journal of the Canadian Ceramic Society *(Canada)*

J. Cardiovascular Surg.
Journal of Cardiovascular Surgery *(Italy)*

J. Catalysis
Journal of Catalysis *(U. S.)*

J. Cell Biol.
Journal of Cell Biology, The (formerly Journal of Biophysical and Biochemical Cytology) *(U. S.)*

J. Cellular Comp. Physiol.
*Journal of Cellular and Comparative Physiology *(U. S.)*

J. Ceram. Assoc. Japan
Journal of the Ceramic Association of Japan
see Yogyo Kyokai Shi

J. Chem. Educ.
Journal of Chemical Education *(U. S.)*

J. Chem. Eng. Data
*Journal of Chemical and Engineering Data *(U. S.)*

J. Chem. Phys.
*Journal of Chemical Physics, The *(U. S.)*

J. Chem. Soc.
*Journal of the Chemical Society (London) *(England)*

J. Chem. Soc. Japan
Journal of the Chemical Society of Japan
see Nippon Kagaku Zasshi

J. Chem. Soc. Japan, Ind. Chem. Sect.
Journal of the Chemical Society of Japan, Industrial Chemistry Section
see Kogyo Kagaku Zasshi

J. Chem. Soc. Japan, Pure Chem. Sect.
Journal of the Chemistry Society of Japan, Pure Chemistry Section
see Nippon Kagaku Zasshi

J. Chim. Phys.
*Journal de Chimie Physique et de Physicochimie Biologique *(France)*

J. Chinese Chem. Soc. (Taiwan)
*Journal of the Chinese Chemical Society (Taiwan) *(China)*

J. Chir. (Paris)
Journal de Chirurgie (Paris) *(France)*

J. Chromatog.
*Journal of Chromatography *(Netherlands)*

J. Chronic Diseases
Journal of Chronic Diseases *(U. S.)*

J. Clay Res. Group Japan
Journal of the Clay Research Group of Japan *(Japan)*

J. Clin. Endrocrinol. Metab.
*Journal of Clinical Endocrinology and Metabolism, The *(U. S.)*

J. Clin. Invest.
*Journal of Clinical Investigation, The *(U. S.)*

J. Clin. Pathol.
Journal of Clinical Pathology *(England)*

J. Coll. Radiologists Australasia
*Journal of the College of Radiologists of Australasia *(Australia)*

J. Comp. Physiol. Psychol.
Journal of Comparative and Physiological Psychology *(U. S.)*

J. Dairy Sci.
Journal of Dairy Science *(U. S.)*

J. Dental Res.
Journal of Dental Research, The *(U. S.)*

J. Econ. Entomol.
Journal of Economic Entomology *(U. S.)*

J. Egypt. Med. Assoc.
*Journal of the Egyptian Medical Association, The *(Egypt)*

J. Electroanal. Chem.
*Journal of Electroanalytical Chemistry *(Netherlands)*

J. Electrochem. Soc.
*Journal of the Electrochemical Society *(U. S.)*

J. Electron. Control
Journal of Electronics and Control *(U. S.)*

J. Electronmicroscopy (Tokyo)
Journal of Electronmicroscopy (Tokyo) *(Japan)*

J. Elisha Mitchell Sci. Soc.
Journal of the Elisha Mitchell Scientific Society *(U. S.)*

J. Embryol. Exptl. Morphol.
*Journal of Embryology and Experimental Morphology *(England)*

J. Endocrinol.
Journal of Endocrinology, The *(England)*

J. Eng. Power
*Journal of Engineering for Power, Transactions of the ASME, Series A *(U. S.)*

J. Environmental Sci.
Journal of Environmental Sciences *(U. S.)*

JETP Letters (USSR) (English Transl.)
*JETP Letters (USSR) (English Translation of Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, Pis'ma v Redaktsiyu) *(U. S.)*

J. Exptl. Biol.
Journal of Experimental Biology, The *(England)*

J. Exptl. Med.
*Journal of Experimental Medicine *(U. S.)*

J. Exptl. Zool.
Journal of Experimental Zoology *(U. S.)*

J. Fac. Agr., Iwate Univ.
Journal of the Faculty of Agriculture, Iwate University
see Iwate Daigaku Nogakubu Hokoku

J. Fac. Agr. Kyushu Univ.
Journal of the Faculty of Agriculture, Kyushu University *(Japan)*

J. Fac. Sci., Hokkaido Univ., Ser. II
Journal of the Faculty of Science, Hokkaido University Series II *(Japan)*

J. Fac. Sci., Hokkaido Univ., Ser. V
Journal of the Faculty of Science, Hokkaido University, Series V *(Japan)*

J. Florida Med. Assoc.
Journal of the Florida Medical Association, Inc., The *(U. S.)*

J. Fluid Mech.
*Journal of Fluid Mechanics *(U. S.)*

J. Food Sci.
Journal of Food Science (formerly Food Research) *(U. S.)*

J. Forensic Sci.
Journal of Forensic Sciences *(U. S.)*

J. Formosan Med. Assoc.
Journal of the Formosan Medical Association
see T'ai-wan I Hsueh Hui Tsa Chih

J. Franc. Med. Chir. Thorac.
Journal Francais de Medecine et Chirurgie Thoracique *(France)*

J. Gas Chromatog.
Journal of Gas Chromatography *(U. S.)*

J. Genet.
*Journal of Genetics *(U. S.)*

J. Genet. Psychol.
Journal of Ganetic Psychology, The *(U. S.)*

J. Gen. Microbiol.
Journal of General Microbiology *(England)*

J. Gen. Physiol.
Journal of General Physiology *(U. S.)*

J. Geol.
Journal of Geology, The *(U.S.)*

J. Geomagnet. Geoelec.
*Journal of Geomagnetism and Geoelectricity *(Japan)*

J. Geophys. Res.
*Journal of Geophysical Research *(U. S.)*

J. Gerontol.
*Journal of Gerontology *(U. S.)*

J. Heat Transfer
*Journal of Heat Transfer, Transactions of the ASME, Series C *(U. S.)*

J. Heterocycl. Chem.
Journal of Heterocyclic Chemistry *(U. S.)*

J. Hiroshima Med. Assoc.
Journal of the Hiroshima Medical Association, The
see Hiroshima Igaku

J. Histochem. Cytochem.
Journal of Histochemistry and Cytochemistry, The *(U. S.)*

J. Hydraulics Div., Am. Soc. Civil Engrs.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Hyg. Epidemiol. Microbiol. Immunol. (Prague)
Journal of Hygiene, Epidemiology, Microbiology, and Immunology (Prague) *(Czechoslovakia)*

Jibi Inko-ka
Jibi Inko-ka (Otolaryngology) *(Japan)*

Jikeikai Med. J.
*Jikeikai Medical Journal *(Japan)*

J. Immunol.
*Journal of Immunology, The *(U. S.)*

J. Indian Chem. Soc.
*Journal of the Indian Chemical Society *(India)*

J. Indian Inst. Sci.
*Journal of the Indian Institute of Science *(India)*

J. Infect. Diseases
Journal of Infectious Diseases, The *(U. S.)*

J. Inorg. Nucl. Chem.
*Journal of Inorganic & Nuclear Chemistry *(England)*

Jinrui Idengaku Zasshi
Jinrui Idengaku Zasshi (Japanese Journal of Human Genetics) *(Japan)*

J. Insect Physiol.
Journal of Insect Physiology *(U.S.)*

J. Inst. Elec. Engrs. (London)
Journal of the Institution of Electrical Engineers (London), The *(England)*

J. Inst. Elec. Engrs. Japan
Journal of the Institute of Electric Engineers of Japan, The
see Denki Gakkai Zasshi

J. Inst. Engrs., Australia
*Journal of the Institution of Engineers, Australia *(Australia)*

J. Inst. Math. Appl.
*Journal of the Institute of Mathematics and Its Applications *(England)*

J. Inst. Metals
*Journal of the Institute of Metals with Bulletin and Metallurgical Abstracts *(England)*

J. Inst. Petrol.
Journal of the Institute of Petroleum *(England)*

J. Inst. Telecommun. Engrs.
Journal of the Institution of Telecommunication Engineers *(India)*

J. Inst. Television Engrs. Japan
Journal of the Institute of Television Engineers of Japan, The
see Terebijon

J. Inst. Water Engrs.
Journal of the Institution of Water Engineers *(England)*

J. Intern. Coll. Surgeons
Journal of the International College of Surgeons, The *(U. S.)*

J. Invertebrate Pathol.
Journal of Invertebrate Pathology (formerly Journal of Insect Pathology) *(U. S.)*

J. Invest. Dermatol.
Journal of Investigative Dermatology, The *(U. S.)*

J. Iowa State Med. Soc.
Journal of the Iowa State Medical Society, The *(U. S.)*

J. Iron Steel Inst. (Japan)
Journal of the Iron and Steel Institute (Japan)
see Tetsu To Hagane

J. Iron Steel Inst. (London)
Journal of the Iron and Steel Institute (London) *(England)*

J. Iwate Med. Assoc.
Journal of the Iwate Medical Association, The
see Iwate Igaku Zasshi

J. Japan. Assoc. Petrol. Technologists
Journal of the Japanese Association of Petroleum Technologists
see Sekiyu Gijutsu Kyokaishi

J. Japan. Chem.
Journal of Japanese Chemistry
see Kagaku No Ryoiki

J. Japan Inst. Metals (Sendai)
Journal of the Japan Institute of Metals (Sendai)
see Nippon Kinzoku Gakkaishi

J. Japan Med. Assoc.
Journal of the Japan Medical Association, The
see Nippon Ishikai Zasshi

J. Japan. Obstet. Gynecol.
Journal of Japanese Obstetrics and Gynecology
see Nippon Sanka Fujinka Gakkai Zasshi

J. Japan. Obstet. Gynecol. Soc.
Journal of the Japanese Obstetrical and Gynecological Society (English edition of Nippon Sanfrojinka Zasshi) *(Japan)*

J. Japan Soc. Civil Engrs.
Journal of the Japan Society of Civil Engineers *(Japan)*

J. Japan. Soc. Food Nutr.
Journal of the Japanese Society of Food and Nutrition
see Eiyo To Shokuryo

J. Japan Welding Soc.
Journal of the Japan Welding Society
see Yosetsu Gakkaishi

J. Joint Panel Nucl. Marine Propulsion
*Journal of the Joint Panel on Nuclear Marine Propulsion *(England)*

J. Kentucky State Med. Assoc.
Journal of the Kentucky State Medical Association, The *(U. S.)*

J. Korean Chem. Soc.
Journal of the Korean Chemical Society
see Ta Han Hua Hsueh Hui-Chih

J. Korean Med. Assoc.
Journal of the Korean Medical Association *(Korea)*

J. Kumamoto Med. Soc.
Journal of the Kumamoto Medical Society, The
see Kumamoto Igakkai Zasshi

J. Kyoto Prefect. Med. Univ.
Journal of the Kyoto Prefecture Medical University
see Furitsu Ikadaigaku Zasshi

J. Lab. Clin. Med.
*Journal of Laboratory and Clinical Medicine, The *(U. S.)*

J. Labelled Compds.
*Journal of Labelled Compounds *(Belgium)*

J. Lancet
Journal-Lancet, The *(U. S.)*

J. Laryngol. Otol.
Journal of Laryngology and Otology, The *(England)*

J. Less-Common Metals
*Journal of the Less-Common Metals *(Netherlands)*

J. Lipid Res.
Journal of Lipid Research *(U. S.)*

J. Marine Biol. Assoc. U. K.
Journal of the Marine Biological Association of the United Kingdom *(England)*

J. Marine Res. (Sears Found. Marine Res.)
Journal of Marine Research (Sears Foundation for Marine Research) *(U. S.)*

J. Math. Anal. Appl.
*Journal of Mathematical Analysis and Applications *(U. S.)*

J. Math. Mech.
Journal of Mathematics and Mechanics *(U. S.)*

J. Math. Phys. (N. Y.)
*Journal of Mathematical Physics (New York) *(U. S.)*

J. Mecan.
*Journal de Mecanique *(France)*

J. Mech. Eng. Sci.
Journal of Mechanical Engineering Science, The *(England)*

J. Med. (Oporto)
Journal do Medico (Oporto) *(Portugal)*

J. Med. Assoc. Georgia
Journal of the Medical Association of Georgia, The *(U. S.)*

J. Med. Assoc. State Alabama
Journal of the Medical Association of the State of Alabama, The *(U. S.)*

J. Med. Bordeaux Sud-Ouest
Journal de Medecine de Bordeaux et du Sud-Ouest *(France)*

J. Med. Chem.
Journal of Medicinal Chemistry *(U. S.)*

J. Med. Educ.
Journal of Medical Education, The *(U. S.)*

J. Med. Pharm. Chem.
Journal of Medicinal and Pharmaceutical Chemistry *(U. S.)*

J. Med. Soc. New Jersey
Journal of the Medical Society of New Jersey *(U. S.)*

J. Metals
*Journal of Metals *(U. S.)*

J. Meteorol.
*Journal of Meteorology, The *(U. S.)*

J. Microscopie
Journal de Microscopie *(France)*

J. Mining Met. Inst. Japan
Journal of Mining and Metallurgical Institute of Japan
see Nippon Kogyo Kaishi

J. Mol. Biol.
*Journal of Molecular Biology *(England)*

J. Mol. Spectry.
*Journal of Molecular Spectroscopy *(U. S.)*

J. Mt. Sinai Hosp., N. Y.
Journal of the Mount Sinai Hospital, New York *(U. S.)*

J. Nagasaki Med. Assoc.
Journal of the Nagasaki Medical Association
see Nagasaki Igakkai Zasshi

J. Natl. Cancer Inst.
*Journal of the National Cancer Institute *(U. S.)*

J. Natl. Res. Council Thailand
*Journal of the National Research Council of Thailand

(contains Part I. Natural Science and Part II. Social Science, paged separately) *(Thailand)*

J. Nat. Sci. Math.
*Journal of Natural Sciences and Mathematics *(Pakistan)*

J. N. D. I. (Japan)
Journal of N. D. I. (Japan)
see Hi-hakai Kensa

J. Neurochem.
Journal of Neurochemistry *(England)*

J. Neurol., Neurosurg., Psychiat.
Journal of Neurology, Neurosurgery, and Psychiatry *(England)*

J. Neuropathol. Exptl. Neurol.
Journal of Neuropathology and Experimental Neurology, The *(U. S.)*

J. Neurosurg.
Journal of Neurosurgery *(U. S.)*

J. New Zealand Inst. Chem.
Journal of the New Zealand Institute of Chemistry *(New Zealand)*

J. Nippon Med. School
Journal of the Nippon Medical School, The
see Nippon Ika Daigaku Zasshi

J. Nucl. Energy: Pt. A & B
*Journal of Nuclear Energy: Parts A & B. Reactor Science and Technology (formerly issued separately) *(England)*

J. Nucl. Energy: Pt. C
*Journal of Nuclear Energy: Part C. Plasma Physics—Accelerators—Thermonuclear Research *(England)*

J. Nucl. Mater.
*Journal of Nuclear Materials (Journal des Materiaux Nucleaires) *(Netherlands)*

J. Nucl. Med.
*Journal of Nuclear Medicine *(U. S.)*

J. Nucl. Sci. Technol. (Tokyo)
*Journal of Nuclear Science and Technology (Tokyo) *(Japan)*

J. Nutr.
Journal of Nutrition, The *(U. S.)*

J. Obstet. Gynaecol. Brit. Commonwealth
Journal of Obstetrics and Gynaecology of the British Commonwealth *(England)*

J. Occupational Med.
Journal of Occupational Medicine *(U. S.)*

Johns Hopkins Univ., Appl. Phys. Lab., Tech. Dig.
Johns Hopkins University, Applied Physics Laboratory, Technical Digest *(U. S.)*

J. Oil Colour Chemists' Assoc.
Journal of the Oil & Colour Chemists' Association *(England)*

J. Okayama Med. Soc.
Journal of Okayama Medical Society
see Okayama Igakkai Zasshi

J. Opt. Soc. Am.
*Journal of the Optical Society of America *(U. S.)*

J. Oral Therap. Pharmacol.
Journal of Oral Therapeutics and Pharmacology *(U. S.)*

J. Organometal. Chem. (Amsterdam)
Journal of Organometallic Chemistry (Amsterdam) *(Netherlands)*

J. Org. Chem.
*Journal of Organic Chemistry, The *(U. S.)*

J. Osaka City Med. Center
Journal of the Osaka City Medical Center, The
see Osaka Shiritsu Daigaku Igaku Zasshi

J. Parasitol.
Journal of Parasitology, The *(U. S.)*

J. Pathol. Bacteriol.
Journal of Pathology and Bacteriology, The *(Scotland)*

J. Pediat.
Journal of Pediatrics, The *(U. S.)*

J. Petrol.
Journal of Petrology *(England)*

J. Pharmacol. Exptl. Therap.
Journal of Pharmacology and Experimental Therapeutics, The *(U. S.)*

J. Pharm. Pharmacol.
Journal of Pharmacy and Pharmacology *(England)*

J. Pharm. Sci.
Journal of Pharmaceutical Sciences *(U. S.)*

J. Pharm. Soc. Japan
Journal of the Pharmaceutical Society of Japan
see Yakugaku Zasshi

J. Phot. Sci.
Journal of Photographic Science *(England)*

J. Phys. (Paris)
*Journal de Physique (Paris) (formerly Le Journal de Physique et le Radium) *(France)*

J. Phys. Chem.
*Journal of Physical Chemistry, The *(U. S.)*

J. Phys. Chem. Solids
*Journal of Physics and Chemistry of Solids (formerly Physics and Chemistry of Solids, The) *(U. S.)*

J. Physiol. (London)
Journal of Physiology, The (London) *(England)*

J. Physiol. (Paris)
Journal de Physiologie (Paris) *(France)*

J. Phys., Phys. Appl. (Paris)
*Journal de Physique, Physique Applique (Paris). Supplement au Journal de Physique (Paris) *(France)*

J. Phys. Radium
Journal de Physique, Le, et Le Radium *(France)*

J. Phys. Soc. Japan
*Journal of the Physical Society of Japan *(Japan)*

J. Polarog. Soc.
Journal of the Polarographic Society *(England)*

J. Polymer Sci. Pt. A
*Journal of Polymer Science. Part A: General Papers *(U. S.)*

J. Polymer Sci. Pt. B
*Journal of Polymer Science. Part B: Polymer Letters *(U. S.)*

J. Polymer Sci. Pt. C
*Journal of Polymer Science. Part C: Polymer Symposia *(U. S.)*

J. Postgraduate Med. (Bombay)
Journal of Postgraduate Medicine (Bombay) *(India)*

J. Pract. Nursing
Journal of Practical Nursing *(U. S.)*

J. Prakt. Chem.
Journal fuer Praktische Chemie *(Germany)*

J. Prosthetic Dentistry
Journal of Prosthetic Dentistry, The *(U. S.)*

J. Protozool.
Journal of Protozoology, The *(U. S.)*

J. Quant. Spectry. Radiative Transfer
*Journal of Quantitative Spectroscopy & Radiative Transfer *(England)*

J. Radiation Res. (Japan)
*Journal of Radiation Research *(Japan)*

J. Radiol., Electrol. Med. Nucl.
*Journal de Radiologie, d'Electrologie, et de Medicine Nucleaire *(France)*

J. Reprod. Fertility
Journal of Reproduction and Fertility *(England)*

J. Res. Inst. Catalysis, Hokkaido Univ.
*Journal of the Research Institute for Catalysis, Hokkaido University *(Japan)*

J. Res. Natl. Bur. Std., A
*Journal of Research of the National Bureau of Standards, A *(U. S.)*

J. Res. Natl. Bur. Std., B
*Journal of Research of the National Bureau of Standards, B *(U. S.)*

J. Res. Natl. Bur. Std., D
*Journal of Research of the National Bureau of Standards, D *(U. S.)*

J. Reticuloendothelial Soc.
*Journal of the Reticuloendothelial Society *(U. S.)*

J. Roy. Army Med. Corps
Journal of the Royal Army Medical Corps *(England)*

J. Roy. Coll. Surgeons Edinburgh
Journal of the Royal College of Surgeons of Edinburgh *(Scotland)*

J. Roy. Inst. Public Health Hyg.
Journal of the Royal Institute of Public Health and Hygiene, The *(England)*

J. Roy. Microscop. Soc.
Journal of the Royal Microscopical Society *(England)*

J. Roy. Naval Med. Serv.
Journal of the Royal Naval Medical Service *(England)*

J. S. African Chem. Inst.
Journal of the South African Chemical Institute *(S. Africa)*

J. Sanit. Eng. Div., Am. Soc. Civil Engrs.
Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Sci. Food Agr.
*Journal of the Science of Food and Agriculture *(England)*

J. Sci. Hiroshima Univ. Ser. A-II
*Journal of Science of the Hiroshima University. Series A-II *(Japan)*

J. Sci. Ind. Res. (India)
*Journal of Scientific and Industrial Research *(India)*

J. Sci. Instr.
*Journal of Scientific Instruments *(England)*

J. Sci. Res. Banaras Hindu Univ.
Journal of Scientific Research of the Banaras Hindu University, The *(India)*

J. Sericult. Sci. Japan
Journal of Sericultural Science of Japan
see Nippon Sanshigaku Zasshi

J. Soc. Ind. Appl. Math.
Journal of the Society of Industrial and Applied Mathematics *(U.S.)*

J. Soc. Instr. Control Engrs. (Tokyo)
Journal of the Society of Instrument and Control Engineers (Tokyo)
see Keisoku To Seigyo

J. Soc. Mater. Sci., Japan
Journal of the Society of Materials Science, Japan *(Japan)*

J. Soc. Sci. Phot. Japan
Journal of the Society of Scientific Photography of Japan, The
see Nippon Shashin Gakkai Kaishi

J. Spacecraft Rockets
Journal of Spacecraft and Rockets *(U. S.)*

J. Spectroscopical Soc. Japan
Journal of the Spectroscopical Society of Japan
see Bunko Kenkyu

J. Surg. Res.
Journal of Surgical Research *(U. S.)*

J. Tech. Lab. (Tokyo)
Journal of Technical Laboratory (Tokyo)
see Gijutsu Kenkyusho Shoho

J. Tenn. Acad. Sci.
*Journal of the Tennessee Academy of Science *(U. S.)*

J. Theoret. Biol.
*Journal of Theoretical Biology *(England)*

J. Thoracic Cardiovascular Surg.
Journal of Thoracic and Cardiovascular Surgery *(U. S.)*

J. Trauma
Journal of Trauma *(U. S.)*

J. Ultrastruct. Res.
*Journal of Ultrastructure Research *(U. S.)*

J. Urol.
Journal of Urology, The *(U. S.)*

J. Vacuum Sci. Technol.
*Journal of Vacuum Science and Technology, The *(U. S.)*

J. Water Pollution Control Federation
Journal of the Water Pollution Control Federation (formerly Sewage and Industrial Wastes) *(U. S.)*

J. Water Waste (Tokyo)
Journal of Water and Waste (Tokyo)
see Yosui To Haisui

J. Waterways Harbors Div., Am. Soc. Civil Engrs.
Journal of the Waterways and Harbors Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Wildlife Management
Journal of Wildlife Management, The *(U. S.)*

Kagaku (Kyoto)
Kagaku (Kyoto) (Chemistry) *(Japan)*

Kagaku Kogaku
Kagaku Kogaku (Chemical Engineering) *(Japan)*

Kagaku Kogyo
Kagaku Kogyo (Chemical Industry) *(Japan)*

Kagaku No Ryoiki
Kagaku No Ryoiki (Journal of Japanese Chemistry) *(Japan)*

Kagaku to Kogyo (Tokyo)
Kagaku to Kogyo (Tokyo) (Chemistry and Chemical Industry) *(Japan)*

Kakuyugo-Kenkyu
Kakuyugo-Kenkyu *(Japan)*

Karyoku Hatsuden
Karyoku Hatsuden (Thermal Power, The) *(Japan)*

Kauchuk i Rezina
Kauchuk i Rezina† *(U.S.S.R.)*

Keikinzoku
Keikinzoku (Light Metals (Tokyo)) *(Japan)*

Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

Kernenergie
*Kernenergie *(Germany)*

Kerntechnik
*Kerntechnik, Isotopentechnik und -Chemie *(Germany)*

KFKI Kozlemen.
KFKI Kozlemenyei
see Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.

Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd.
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-fysiske Meddelelser *(Denmark)*

Kgl. Danske Videnskab. Selskab, Mat.-Fys. Skrifter
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-Fysiske Skrifter *(Denmark)*

Kgl. Norske Videnskab. Selskabs, Forh.
*Kongelige Norske Videnskabers Selskabs, Det, Forhandlinger *(Norway)*

Khim. i Neft. Mashinostr.
Khimicheskoe i Neftyanoe Mashinostroenie *(U.S.S.R.)*

Khim. i Tekhnol. Topliv i Masel
Khimiya i Tekhnologiya Topliv i Masel *(U.S.S.R.)*

Khim. Volokna
Khimicheskie Volokna *(U.S.S.R.)*

Kibernetika
*Kibernetika *(Ukrainian S.S.R.)*

Kikai No Kenkyu
Kikai No Kenkyu (Science of Machine) *(Japan)*

Kinetika i Kataliz
*Kinetika i Kataliz† *(U.S.S.R.)*

Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku
Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku (Report of National Research Institute for Metals) *(Japan)*

Kiserl. Orvostud.
Kiserletes Orvostudomany *(Hungary)*

Kitakanto Igaku
Kitakanto Igaku (Kitakanto Medical Journal) *(Japan)*

Kitakanto Med. J.
Kitakanto Medical Journal
see Kitakanto Igaku

Klinich. Med.
Klinicheskaya Meditsina *(U.S.S.R.)*

Klin. Med. (Vienna)
Klinische Medizin (Vienna) *(Austria)*

Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(Germany)*

Klin. Wochschr.
*Klinische Wochenschrift *(Germany)*

Kobe J. Med. Sci.
Kobe Journal of the Medical Sciences, The *(Japan)*

Kobe Steel Works Eng. Rept.
Kobe Steel Works Engineering Reports *(Japan)*

Kobunshi Kagaku
Kobunshi Kagaku (Chemistry of High Polymers) *(Japan)*

Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku
Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku (Report of the Fermentation Research Institute) *(Japan)*

Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku
Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku (Bulletin of the Textile Research Institute of Japanese Government) *(Japan)*

Kogyo Kagaku Zasshi
Kogyo Kagaku Zasshi (Journal of the Chemical Society of Japan, Industrial Chemistry Section) *(Japan)*

Kogyo Reametaru
Kogyo Reametaru (Rare Metals) *(Japan)*

Kogyo Zairyo
Kogyo Zairyo (Engineering Materials) *(Japan)*

Kohasz. Lapok
Kohaszati Lapok *(Hungary)*

K'o Hsueh T'ung Pao
*K'o Hsueh T'ung Pao (Scientia) *(China)*

Kolloidn. Zh.
Kolloidnyi Zhurnal† *(U.S.S.R.)*

Kolloid-Z.
Kolloid-Zeitschrift *(Germany)*

Koninkl. Ned. Akad. Wetenschap., Proc., Ser. B.
*Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, Series B *(Netherlands)*

Konservn. i Ovoshchesushil. Prom.
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*

Korean J. Internal Med.
Korean Journal of Internal Medicine, The *(Korea)*

Korean J. Zool.
Korean Journal of Zoology, The *(Korea)*

Koshu Eiseiin Kenkyu Hokoku
Koshu Eiseiin Kenkyu Hokoku (Bulletin of the Institute of Public Health) *(Japan)*

Kosmich. Issled.
*Kosmicheskie Issledovaniya† *(U.S.S.R.)*

Kosmos (Warsaw) Ser. A
*Kosmos (Warsaw) Seria A: Biologia *(Poland)*

Kovove Mater.
Kovove Materialy *(Czechoslovakia)*

Krebsarzt
Krebsarzt, Der *(Austria)*

Kristallografiya
Kristallografiya† *(U.S.S.R.)*

Krupp Tech. Rev. (English Transl. Tech. Mitt. Krupp, Werksber.)
*Krupp Technical Review (English Translation of Technische Mitteilungen Krupp, Werksberichte) *(Germany)*

Kulturpflanze
Kulturpflanze, Die *(Germany)*

Kumamoto Igakkai Zasshi
Kumamoto Igakkai Zasshi (The Journal of the Kumamoto Medical Society) *(Japan)*

K'un Ch'ung Hsueh Pao
K'un Ch'ung Hsueh Pao (Acta Entomologica Sinica) *(China)*

Kwart. Geol.
*Kwartalnik Geologiczny *(Poland)*

Kyushu J. Med. Sci.
Kyushu Journal of Medical Science *(Japan)*

Lab. Animal Care
Laboratory Animal Care *(U. S.)*

Lab. Invest.
Laboratory Investigation *(U. S.)*

Lahey Clin. Bull.
Lahey Clinic Bulletin, The *(U. S.)*

Lancet
Lancet, The *(England)*

Landwirtsch. Forsch.
Landwirtschaftliche Forschung *(Germany)*

Lantbrukshogskol. Ann.
Lantbrukshogskolans Annaler *(Sweden)*

Laryngoscope
Laryngoscope, The *(U. S.)*

Lattante
Lattante, Il *(Italy)*

Latvijas PSR Zinatnu Akad. Vestis
*Latvijas PSR Zinatnu Akademijas Vestis *(Latvian S.S.R.)*

Latvijas PSR Zinatnu Akad. Vestis, Fiz. Tek. Zinatnu Ser.
*Latvijas PSR Zinatnu Akademijas Vestis, Fizikas un Teknisko Zinatnu Serija *(Latvian S.S.R.)*

Laval Med.
Laval Medical *(Canada)*

Lectures Many-Body Probl.
Lectures on the Many-Body Problem *(U. S.)*

Leder
Leder, Das *(Germany)*

Leech
Leech *(S. Africa)*

Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos
*Lietuvos Fizikos Rinkinys, Lietuvos TSR Mokslu Akademija, Lietuvos TSR Aukstosios Mokyklos *(Lithuanian S.S.R.)*

Lietuvos TSR Mokslu Akad. Darbai: Ser. B
*Lietuvos TSR Mokslu Akademija Darbai: Serija B *(Lithuanian S.S.R.)*

Life Sci.
Life Sciences *(U. S.)*

Light Metal Age
Light Metal Age *(U. S.)*

Light Metals
Light Metals *(England)*

Light Metals (Tokyo)
Light Metals (Tokyo)
see Keikinzoku

Lille Med.
*Lille Medical *(France)*

Limnol. Oceanog.
*Limnology and Oceanography *(U. S.)*

Litovsk. Mat. Sb.
*Litovskii Matematicheskikh Sbornik *(Lithuanian S.S.R.)*

Lloydia
Lloydia *(U. S.)*

Lockheed Georgia Quart.
*Lockheed Georgia Quarterly *(U. S.)*

Lodz. Towarz. Nauk., Wydzial III, Acta Chim.
*Lodzkie Towarzystwo Naukowe, Wydzial III, Acta Chimica *(Poland)*

Louisana Law Rev.
Louisana Law Review *(U. S.)*

Lyon Chir.
Lyon Chirurgical *(France)*

Lyon Med.
Lyon Medical *(France)*

Maandschr. Kindergeneesk.
Maandschrift voor Kindergeneeskunde *(Netherlands)*

Machinery Lloyd
*Machinery Lloyd *(England)*

Madjalah Inst. Tekn. Bandung Proc.
*Madjalah Institut Teknologi Bandung Proceedings *(Indonesia)*

Magnitn. Gidrodin.
*Magnitnaya Gidrodinamika *(Latvian S.S.R.)*

Mag. Std.
Magazine of Standards, The *(U. S.)*

Magy. Allatorv. Lapja
Magyar Allatorvosok Lapja *(Hungary)*

Magy. Fiz. Folyoirat
*Magyar Fizikai Folyoirat *(Hungary)*

Magy. Kem. Folyoirat
*Magyar Kemiai Folyoirat *(Hungary)*

Magy. Kem. Lapja
*Magyar Kemikusok Lapja *(Hungary)*

Magy. Radiol.
*Magyar Radiologia *(Hungary)*

Magy. Textiltech.
Magyar Textiltechnika *(Hungary)*

Magy. Tud. Akad. At. Kut. Int. (Debrecen). Kozlemen.
Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek
see At. Kozlemen.

Magy. Tud. Akad. Biol. Tud. Oszt. Kozlemen.
Magyar Tudomanyos Akademia Biologia Tudomanyok Osztalyanak Kozlemenyei, A *(Hungary)*

Magy. Tud. Akad. Kem. Tud. Oszt. Kozlemen.
Magyar Tudomanyos Akademia, Kemiai Tudomanyok Osztalyanak, Kozlemenyei, A *(Hungary)*

Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.
*Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezetenek Kozlemenyei *(Hungary)*

Magy. Tud. Akad., Muszaki Tud. Oszt. Kozlemen.
*Magyar Tudomanyos Akademia Muszaki Tudomanyok Osztalyanak Kozlemenyei *(Hungary)*

Makromol. Chem.
Makromolekulare Chemie *(Switzerland)*

Mal. Cardiovascolari
*Malattie Cardiovascolari *(Italy)*

Manitoba Med. Rev.
Manitoba Medical Review *(Canada)*

Maroc Med.
Marco Medical *(Morocco)*

Marseille-Med.
Marseille-Medical *(France)*

Mass Spectry. (Tokyo)
Mass Spectroscopy (Tokyo)
see Shitsuryo Bunseki

Mater. Design Eng.
*Materials in Design Engineering (formerly Materials & Methods) *(U. S.)*

Mater. Evaluation
*Materials Evaluation (formerly Nondestructive Testing) *(U. S.)*

Materialy po Toksikol. Radioaktivn. Veshchestv, Akad. Med. Nauk SSSR
Materialy po Toksikologii Radioaktivnykh Veshchestv, Akademiya Meditsinskikh Nauk SSSR *(U.S.S.R.)*

Mater. Med. Nordmark
Materia Medica Nordmark *(Germany)*

Mater. Protect.
Materials Protection *(U. S.)*

Mater. Res. Std.
*Materials Research & Standards (Formerly ASTM (American Society for Testing Materials) Bulletin) *(U. S.)*

Mayo Clin. Proc.
Mayo Clinic Proceedings *(U. S.)*

Mech. Eng.
Mechanical Engineering *(U. S.)*
Med. Ann. District Columbia
Medical Annals of the District of Columbia *(U. S.)*
Med. Biol. (Tokyo)
Medicine and Biology (Tokyo)
see Igaku To Seibutsugaku
Med. Biol. Illus.
Medical and Biological Illustration *(England)*
Med. Bull. U. S. Army, Europe
Medical Bulletin of the U. S. Army, Europe
Med., Clr., Farm.
Medicina, Cirurgia, Farmacia *(Brazil)*
Med. Clr. Guerra
Medicina y Cirugia de Guerra *(Spain)*
Med. Clin. (Barcelona)
Medicina Clinica (Barcelona) *(Spain)*
Med. Clin. N. Am.
Medical Clinics of North America, The *(U. S.)*
Med. Doswiadczalna Mikrobiol.
*Medycyna Doswiadczalna i Mikrobiologia *(Poland)*
Med. Ernaehr.
Medizin und Ernaehrung *(Germany)*
Med. Exptl.
*Medicina Experimentalis *(Switzerland)*
Med. Glasnik
*Medicinski Glasnik *(Yugoslavia)*
Medicamundi
*Medicamundi *(Netherlands)*
Medicina (Buenos Aires)
Medicina (Buenos Aires) *(Argentina)*
Medicina (Mex.)
*Medicina *(Mexico)*
Medicine (Tokyo)
Medicine (Tokyo)
see Sogo Igaku
Med. Interna
Medicina Interna *(Romania)*
Med. J. Australia
Medical Journal of Australia, The *(Australia)*
Med. J. Hiroshima Univ.
*Medical Journal of Hiroshima University *(Japan)*
Med. J. Malaya
*Medical Journal of Malaya, The *(Malaya)*
Med. J. Shinshu Univ.
*Medical Journal of Shinshu University *(Japan)*
Med. Klin. (Munich)
Medizinische Klinik (Munich) *(Germany)*
Med. Monatsschr.
Medizinische Monatsschrift *(Germany)*
Med. Officer
Medical Officer *(England)*
Med. Parazitol. i Parazitarn. Bolezni
Meditsinskaya Parazitologiya i Parazitarnye Bolezni *(U.S.S.R.)*
Med. Pharmacol. Exptl.
Medicine et Pharmacologia Experimentalis (formerly Medicina Experimentalis) *(Switzerland)*
Med. Pracy
*Medycyna Pracy *(Poland)*
Med. Pregled
Meditsinski Pregled *(Yugoslavia)*
Med. Radiography Phot.
Medical Radiography and Photography *(U. S.)*
Med. Radiol.
*Meditsinskaya Radiologiya† *(U.S.S.R.)*
Med. Sachverstaend.
Medizinische Sachverstaendige *(Germany)*
Med. Serv. J. (Can.)
Medical Service Journal *(Canada)*
Med. Times
Medical Times *(U. S.)*
Med. Trop. (Madrid)
Medicina Tropical, La (Madrid) *(Spain)*
Med. Welt
Medizinsche Welt, Die *(Germany)*
Med. Weterynar. (Poland)
Medycyna Weterynaryjna *(Poland)*
Med. Zh. Uzbekistana
Meditsinskii Zhurnal Uzbekistana *(Uzbek S.S.R.)*
Meidensha Jiho
Meidensha Jiho (Meidensha Review) *(Japan)*

Meidensha Rev.
Meidensha Review
see Meidensha Jiho
Melliand Textilber.
Melliand Textilberichte *(Germany)*
Mem. Acad. Chir.
Memoires de l'Academie de Chirurgie *(France)*
Mem. Acad. Roy. Med. Belg.
*Memoires de l'Academie Royale de Medecine de Belgique *(Belgium)*
Mem. Actividades Desarrolladas Patronato "Juan de la Cierva" Invest. Tec., Consejo Super. Invest. Cient.
*Memoria de las Actividades Desarrolladas por el Patronato "Juan de la Cierva" de Investigacion Tecnica, Consejo Superior de Investigaciones Cientificas *(Spain)*
Mem. Coll. Sci., Univ. Kyoto, Ser. B
*Memoirs of the College of Science, University of Kyoto, Series B *(Japan)*
Mem. Fac. Eng., Kyoto Univ.
Memoirs of the Faculty of Engineering, Kyoto University *(Japan)*
Mem. Fac. Liberal Arts Educ., Yamanashi Univ.
Memoirs of the Faculty of Liberal Arts and Education, Yamanashi University *(Japan)*
Mem. Fac. Sci., Kyushu Univ., Ser. C
Memoirs of the Faculty of Science, Kyushu University, Series C *(Japan)*
Mem. Inst. Sci. Ind. Res. Osaka Univ.
Memoirs of the Institute of Scientific and Industrial Research, Osaka University *(Japan)*
Mem. Kakioka Magnetic Obs.
Memoirs of the Kakioka Magnetic Observatory
see Chijiki Kanzokujo Yoho
Mem. Konan Univ., Sci. Ser.
Memoirs of the Konan University, Science Series *(Japan)*
Mem. Muroran Univ. Eng.
Memoirs of the Muroran University of Engineering
see Muroran Kogyo Daigaku Kenkyu Kokoku
Mem. Roy. Astron. Soc.
*Memoirs of the Royal Astronomical Society *(England)*
Mem. School Sci. Eng., Waseda Univ.
Memoirs of the School of Science & Engineering, Waseda University (formerly Memoirs of the Faculty of Science & Engineering, Waseda University, Tokyo, Japan) *(Japan)*
Mem. Sci. Rev. Met.
*Memoires Scientifiques de la Revue de Metallurgie, Les (formerly a part of Revue de Metallurgie) *(France)*
Mem. Soc. Roy. Sci. Liege
*Memoires de la Societe Royale des Sciences de Liege *(Belgium)*
Meres es Automat.
Meres es Automatika *(Hungary)*
Mesures Controle Ind.
Mesures et Controle Industriel *(France)*
Metab., Clin. Exptl.
Metabolism, Clinical and Experimental *(U. S.)*
Metal Ind. (London)
Metal Industry, The (London) *(England)*
Metall
*Metall *(Germany)*
Metalloved. i Term. Obrabotka Metal.
*Metallovedenie i Termicheskaya Obrabotka Metallov† (formerly Metallovedenie i Obrabotka Metallov) *(U.S.S.R.)*
Metall-Reinig. Vorbehandl.
Metall-Reinigung & Vorbehandlung *(Germany)*
Metallurgia
*Metallurgia *(England)*
Metal Progr.
*Metal Progress *(U. S.)*
Metals Eng. Quart.
*Metals Engineering Quarterly *(U. S.)*
Metal Treat. Drop Forging
Metal Treatment and Drop Forging *(England)*
Metanisreba Tekhn.
Metanisreba da Tekhnika *(Georgian S.S.R.)*
Metaux (Corrosion-Ind.)
*Metaux (Corrosion-Industries) *(France)*
Meteorol. i Gidrol.
Meteorologiya i Gidrologiya *(U.S.S.R.)*
Meteorol. Zpravy
*Meteorologicke Zpravy *(Czechoslovakia)*

Methods Cell Physiol.
Methods in Cell Physiology *(U. S.)*

Methods Inform. Med.
Methods of Information in Medicine (supersedes Medical Documentation) *(Germany)*

Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot
Metallurgiya i Metallovedenie Chistykh Metallov, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Nauchnykh Rabot *(U.S.S.R.)*

Met. Ital.
*Metallurgia Italiana, La *(Italy)*

Metody Khim. Analiza Mineral'n. Syr'ya, Vses. Nauchn.-Issled. Inst. Mineral'n. Syr'ya
Metody Khimicheskogo Analiza Mineral'nogo Syr'ya, Vsesoyuznyi Nauchno-Issledovatel'skii Institut Mineral'nogo Syr'ya *(U.S.S.R.)*

Met. Rev.
*Metallurgical Reviews *(England)*

Metrologia
Metrologia *(Germany)*

Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser.
Metallurgical Society, American Institute of Mining, Metallurgical and Petroleum Engineers, Institute of Metals Division, Special Report Series *(U. S.)*

Microchem. J.
*Microchemical Journal *(U. S.)*

Microtecnic
Microtecnic *(Switzerland)*

Mikrobiologiya
Mikrobiologiya† *(U.S.S.R.)*

Mikrobiol. Zh., Akad. Nauk Ukr. RSR
Mikrobiologichnii Zhurnal, Akademiya Nauk Ukrains'koi RSR, Institut Mikrobiologii imeni D. K. Zabolotnogo *(Ukrainian S.S.R.)*

Mikrochim. Acta
Mikrochimica Acta *(Austria)*

Mikrochim. Ichnoanal. Acta
*Mikrochimica et Ichnoanalytica Acta (formerly Mikrochimica Acta) *(Austria)*

Milchwissenschaft
Milchwissenschaft *(Germany)*

Mineral. Mag.
Mineralogical Magazine and Journal of the Mineralogical Society, The *(England)*

Minerva Chir.
Minerva Chirgica *(Italy)*

Minerva Dermatol.
Minerva Dermatologica *(Italy)*

Minerva Fisioterap.
Minerva Fisioterapica *(Italy)*

Minerva Ginecol.
Minerva Ginecologica *(Italy)*

Minerva Med.
Minerva Medica *(Italy)*

Minerva Nucl.
*Minerva Nucleare *(Italy)*

Minerva Ortoped.
Minerva Ortopedica *(Italy)*

Minerva Radiol., Fisioterap. Radiobiol.
*Minerva Radiologica, Fisioterapica e Radiobiologica *(Italy)*

Minerva Urol.
Minerva Urologica *(Italy)*

Mining Ann. Rev.
Mining Annual Review *(England)*

Mining Can.
*Mining in Canada (formerly Precambrian) *(Canada)*

Mining Safety (Japan)
Mining and Safety (Japan)
see *Saiko To Hoan*

Minn. Med.
Minnesota Medicine *(U. S.)*

Missili
Missili *(Italy)*

Mitsubishi Denki Giho
Mitsubishi Denki Giho *(Japan)*

Mitsubishi Denki Lab. Rept.
Mitsubishi Denki Laboratory Reports *(Japan)*

Mitsubishi Heavy Ind. Tech. Rev.
Mitsubishi Heavy Industries Technical Review *(Japan)*

Mitt. Deut. Pharm. Ges.
Mitteilungen der Deutschen Pharmazeutischen Gesellschaft und der Pharmazeutischen Gesellschaft der DDR (included in Archiv der Pharmazie und Berichte der Deutschen Pharmazeutischen Gesellschaft) *(Germany)*

Mitteilungsbl. Strahlungsmessgeraete
*Mitteilungsblaetter Strahlungsmessgeraete *(Germany)*

Mitt. Oesterr. Sanitaetsverwalt.
Mitteilungen der Oesterreichen Sanitaetsverwaltung *(Austria)*

Mizushori Gijutsu
Mizushori Gijutsu *(Japan)*

Mod. Castings
Modern Castings (includes New Technology Section) *(U. S.)*

Mod. Castings, New Technol. Sect.
Modern Castings, New Technology Section (included in Modern Castings) *(U. S.)*

Mod. Metals
Modern Metals *(U. S.)*

Mod. Power Eng.
*Modern Power and Engineering *(Canada)*

Mol. Phys.
*Molecular Physics *(U. S.)*

Monatsber. Deut. Akad. Wiss. Berlin
*Monatsberichte der Deutschen Akademie der Wissenschaften zu Berlin *(Germany)*

Monatsh. Chem.
Monatshefte fuer Chemie und Verwandte Teile Anderer Wissenschaften *(Austria)*

Monatsschr. Kinderheilk.
Monatsschrift fuer Kinderheilkunde *(Germany)*

Monatsschr. Ohrenheilk. Laryngo-Rhinol.
Monatsschrift fuer Ohrenheilkunde und Laryngo-Rhinologie *(Austria)*

Moniteur Belge (Brussels)
Moniteur Belge (Brussels) *(Belgium)*

Monthly Notices Roy. Astron. Soc.
*Monthly Notices of the Royal Astronomical Society *(England)*

Montpellier Med.
*Montpellier Medical *(France)*

Mosquito News
Mosquito News *(U. S.)*

Muench. Med. Wochschr.
Muenchener Medizinische Wochenschrift *(Germany)*

Muroran Kogyo Daigaku Kenkyu Hokoku
Muroran Kogyo Daigaku Kenkyu Hokoku (Memoirs of the Muroran University of Engineering) *(Japan)*

Mutation Res.
*Mutation Research *(Netherlands)*

Mutech Chem. Eng. J.
Mutech Chemical Engineering Journal *(England)*

Mycologia
Mycologia *(U. S.)*

Nagasaki Igakkai Zasshi
Nagasaki Igakkai Zasshi (Journal of the Nagasaki Medical Association) *(Japan)*

Nagoya Kogyo Gijutsu Shikensho Hokoku
Nagoya Kogyo Gijutsu Shikensho Hokoku (Reports of the Government Industrial Research Institute, Nagoya) *(Japan)*

Nagoya Med. J.
Nagoya Medical Journal *(Japan)*

Nahrung
Nahrung, Die *(Germany)*

Naika
Naika (Internal Medicine (Tokyo)) *(Japan)*

Naika Hokan
Naika Hokan (Japanese Archives of Internal Medicine) *(Japan)*

Natl. Bur. Std. (U. S.), Tech. News Bull.
National Bureau of Standards (U. S.), Technical News Bulletin *(U. S.)*

Natl. Cancer Inst. Monograph
National Cancer Institute Monograph *(U. S.)*

Natl. Inst. Animal Health Quart.
*National Institute of Animal Health Quarterly (Tokyo) *(Japan)*

Natl. Tech. Rept. (Matsushita Elec. Ind. Co., Osaka)
National Technical Report (Matsushita Electric Industrial Co., Osaka) *(Japan)*

Natura, Ser. Biol.
Natura, Seria Biologie *(Romania)*

Nature
*Nature (London) *(England)*

Naturwissenschaften
*Naturwissenschaften, Die *(Germany)*

Naturw. Rundschau
Naturwissenschaftliche Rundschau *(Germany)*

Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki
Nauchnye Doklady Vysshei Shkoly, Biologicheskie Nauki *(U.S.S.R.)*

Nauchn. Tr., Irkutskii Gos. Nauchn.-Issled. Inst. Redkikh Metal.
Nauchnye Trudy, Irkutskii Gosudarstvennyi Nauchno-Issledovatel'skii Institut Redkikh Metallov *(U.S.S.R.)*

Nauchn. Tr. Visshiya Med. Inst., Sofiya
Nauchni Trudov na Visshiya Meditsinski Institut, Sofiya *(Bulgaria)*

Nauka i Zhittya
Nauka i Zhittya *(Ukrainian S.S.R.)*

Nauka i Zhizn
Nauka i Zhizn *(U.S.S.R.)*

Naval Engrs.' J.
Naval Engineers' Journal *(U. S.)*

NEC Res. Develop.
NEC Research and Development *(Japan)*

Ned. Tijdschr. Geneesk.
Nederlandsch Tijdschrift voor Geneeskunde *(Netherlands)*

Ned. Tijdschr. Natuurk.
*Nederlands Tijdschrift voor Natuurkunde *(Netherlands)*

Neftekhimiya
Neftekhimiya *(U.S.S.R.)*

Neoplasma
*Neoplasma *(Czechoslovakia)*

Nepegeszsegugy
Nepegeszsegugy *(Hungary)*

Neue Huette
Neue Huette *(Germany)*

Neue Physik
Neue Physik *(Austria)*

Neue Tech.
*Neue Technik *(Switzerland)*

Neurology
Neurology *(U. S.)*

Neuropsichiatria
Neuropsichiatria *(Italy)*

New Engl. J. Med.
New England Journal of Medicine, The *(U. S.)*

New Phys. (Korea)
*New Physics *(Korea)*

New Phytologist
New Phytologist, The *(England)*

New Scientist
*New Scientist, The *(England)*

New Zealand Med. J.
New Zealand Medical Journal, The *(New Zealand)*

Nichidai Igaku Zasshi
Nichidai Igaku Zasshi (Nippon University Medical Journal) *(Japan)*

Niigata Daigaku Kogakubu Kenkyu Hokoku
Niigata Daigaku Kogakubu Kenkyu Hokoku (Research Reports of the Faculty of Engineering, Niigata University) *(Japan)*

Nippon Acta Radiol.
Nippon Acta Radiologica
see Nippon Igaku Hoshasen Gakkai Zasshi

Nippon Butsuri Gakkaisi
Nippon Butsuri Gakkaisi (Proceedings of the Physical Society of Japan) *(Japan)*

Nippon Eiseigaku Zasshi
Nippon Eiseigaku Zasshi (Japanese Journal of Hygiene) *(Japan)*

Nippon Ganka Gakkai Zasshi
Nippon Ganka Gakkai Zasshi (Acta Societatis Ophthalmologicae Japonicae) *(Japan)*

Nippon Ganka Kiyo
Nippon Ganka Kiyo (Folia Ophthalmologica Japonica) *(Japan)*

Nippon Genshiryoku Gakkaishi
*Nippon Genshiryoku Gakkaishi (Journal of the Atomic Energy Society of Japan) *(Japan)*

Nippon Hinyokika Gakkai Zasshi
Nippon Hinyokika Gakkai Zasshi (Japanese Journal of Urology) *(Japan)*

Nippon Hoshasen Gijutsu Gakkai Zasshi
Nippon Hoshasen Gijutsu Gakkai Zasshi (Japanese Journal of Radiological Technology) *(Japan)*

Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo
*Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo (Annual Report of the Japanese Association for Radiation Research on Polymers) *(Japan)*

Nippon Igaku Hoshasen Gakkai Zasshi
Nippon Igaku Hoshasen Gakkai Zasshi (Nippon Acta Radiologica) *(Japan)*

Nippon Ika Daigaku Zasshi
Nippon Ika Daigaku Zasshi (The Journal of the Nippon Medical School) *(Japan)*

Nippon Ishikai Zasshi
Nippon Ishikai Zasshi (The Journal of the Japan Medical Association) *(Japan)*

Nippon Juigaku Zasshi
Nippon Juigaku Zasshi (Japanese Journal of Veterinary Science) *(Japan)*

Nippon Kagaku Zasshi
*Nippon Kagaku Zasshi (Journal of the Chemistry Society of Japan, Pure Chemistry Section) *(Japan)*

Nippon Ketsueki Gakkai Zasshi
Nippon Ketsueki Gakkai Zasshi (Acta Haematologica Japonica) *(Japan)*

Nippon Kikai Gakkai Ronbunshu
Nippon Kikai Gakkai Ronbunshu (Transactions of the Japan Society of Mechanical Engineers) *(Japan)*

Nippon Kinzoku Gakkaishi
*Nippon Kinzoku Gakkaishi (Journal of the Japan Institute of Metals (Sendai)) *(Japan)*

Nippon Kogyo Kaishi
Nippon Kogyo Kaishi (Journal of the Mining and Metallurgical Institute of Japan) *(Japan)*

Nippon Kokan Giho
Nippon Kokan Giho (Nippon Kokan Technical Report) *(Japan)*

Nippon Kokan Tech. Rept.
Nippon Kokan Technical Report
see Nippon Kokan Giho

Nippon Koshu Eisei Zasshi
Nippon Koshu Eisei Zasshi (Japanese Journal of Public Health) *(Japan)*

Nippon Kyobu Rinsho
Nippon Kyobu Rinsho (The Japanese Journal of Chest Diseases) *(Japan)*

Nippon Nogeikagaku Kaishi
Nippon Nogeikagaku Kaishi (Journal of the Agricultural Chemical Society of Japan) *(Japan)*

Nippon Sanka Fujinka Gakkai Zasshi
Nippon Sanka Fujinka Gakkai Zasshi (Journal of Japanese Obstetrics and Gynecology) *(Japan)*

Nippon Sanshigaku Zasshi
Nippon Sanshigaku Zasshi (Journal of the Sericultural Science of Japan) *(Japan)*

Nippon Seiko Giho
Nippon Seiko Giho (Japan Steel Works Technical Review) *(Japan)*

Nippon Shashin Gakkai Kaishi
Nippon Shashin Gakkai Kaishi (The Journal of the Society of Scientific Photography of Japan) *(Japan)*

Nippon Suisan Gakkaishi
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) *(Japan)*

Nippon Univ. J. Med.
Nippon University Journal of Medicine *(Japan)*

Nippon Univ. J. Radiation Med. Biol.
Nippon University Journal of Radiation Medicine and Biology, The *(Japan)*

Nippon Univ. Med. J.
Nippon University Medical Journal
see Nichidai Igaku Zasshi

Nogyo Gijutsu Kenkyusho Hokoku, Chikusan
Nogyo Gijutsu Kenkyusho Hokoku (Bulletin of the National Institute of Agricultural Sciences), Chikusan (Series G) *(Japan)*

Nondestructive Testing
Nondestructive Testing (Journal of the Society of Nondestructive Testing) *(U. S.)*

Nord. Hyg. Tidskr.
Nordisk Hygienisk Tidskrift *(Denmark)*

Nord. Med.
Nordisk Medicin *(Norway)*

Norelco Reptr.
Norelco Reporter *(U. S.)*

Northwest Med.
Northwest Medicine *(U. S.)*

Notas Fis., Centro Brasil. Pesquisas Fis.
*Notas de Fisica, Centro Brasileiro de Pesquisas Fisicas *(Brazil)*

Notiz. Ric. Sci.
Notiziario de "La Ricerca Scientifica" *(Italy)*

Nouvelle Rev. Franc. Hematol.
Nouvelle Revue Francaise d'Hematologie *(France)*

Nowotwory
Nowotwory *(Poland)*

Nucl. Appl.
Nuclear Applications *(U. S.)*

Nucl.-Chicago Tech. Bull.
Nuclear-Chicago Technical Bulletin *(U. S.)*

Nucl. Energy
*Nuclear Energy (formerly Nuclear Energy Engineer) *(England)*

Nucl. Eng.
*Nuclear Engineering incorporating Nuclear Power *(England)*

Nucl. Eng. (Tokyo)
Nuclear Engineering (Tokyo)
see Genshiryoku Kogyo

Nucl. Eng. Bull.
*Nuclear Engineering Bulletin *(U. S.)*

Nucleonics
*Nucleonics *(U. S.)*

Nucleus (Calcutta)
Nucleus (Calcutta) *(India)*

Nucleus (Chicago)
Nucleus (Chicago), The *(U. S.)*

Nucleus (Lahore)
Nucleus (Lahore) *(Pakistan)*

Nucleus (Paris)
*Nucleus. La Revue Scientifique a l'Age Atomique (Paris) *(France)*

Nucl. Fusion
*Nuclear Fusion (Journal of Plasma Physics and Thermonuclear Fusion *(Austria)*

Nucl. Hematol.
Nuclear Hematology (included in Nuclear Energy, paged separately) *(England)*

Nucl. Inform.
*Nuclear Information *(U. S.)*

Nucl. Instr. Methods
*Nuclear Instruments & Methods (formerly Nuclear Instruments) *(Netherlands)*

Nucl.-Med.
*Nuclear-Medizin *(Germany)*

Nucl. News
*Nuclear News *(U. S.)*

Nucl. Phys.
*Nuclear Physics *(Netherlands)*

Nucl. Powered Ship Res. Assoc. Japan
Nuclear Powered Ship Research Association of Japan *(Japan)*

Nucl. Safety
*Nuclear Safety (A Quarterly Technical Progress Review) *(U. S.)*

Nucl. Sci. (Taiwan)
Nuclear Science (Taiwan) *(China)*
see Ho Tsu K'o Hsueh

Nucl. Sci. Abstr. Japan
*Nuclear Science Abstracts of Japan *(Japan)*

Nucl. Sci. Eng.
*Nuclear Science and Engineering *(U. S.)*

Nucl. Struct. Eng.
*Nuclear Structural Engineering *(Netherlands)*

Nukl. Energija
*Nuklearna Energija *(Yugoslavia)*

Nukleonik
*Nukleonik *(Germany)*

Nukleonika
*Nukleonika† *(Poland)*

Nuntius Radiol.
*Nuntius Radiologicus *(Italy)*

Nuovi Ann. Igiene Microbiol.
Nuovi Annali d'Igiene e Microbiologia *(Italy)*

Nuovo Cimento
*Nuovo Cimento (Including all supplements) *(Italy)*

Nursing Times
Nursing Times *(England)*

N. Y. State J. Med.
New York State Journal of Medicine *(U. S.)*

Obstet. Gynecol.
Obstetrics and Gynecology *(U. S.)*

Odontol. Revy
Odontologisk Revy *(Sweden)*

Odontol. Tidskr.
Odontologisk Tidskrift *(Sweden)*

Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz.
Oesterreichische Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, Anzeiger *(Austria)*

Oesterr. Chemiker-Ztg.
Oesterreichische Chemiker-Zeitung *(Austria)*

Ogneupory
*Ogneupory† *(U.S.S.R.)*

Ohio J. Sci.
Ohio Journal of Science, The *(U. S.)*

Ohio State Med. J.
Ohio State Medical Journal, The *(U. S.)*

Okajimas Folia Anat. Japon.
Okajimas Folia Anatomica Japonica *(Japan)*

Okayama Igakkai Zasshi
*Okayama Igakkai Zasshi (Journal of the Okayama Medical Society) *(Japan)*

Okeanologiya
Okeanologiya *(U.S.S.R.)*

Oncologia
*Oncologia *(Switzerland)*

Oncol. Radiol.
Oncologia si Radiologia *(Romania)*

Onde Elec.
*Onde Electrique, L' *(France)*

Ontario Hydro Res. News
*Ontario Hydro Research News *(Canada)*

Ophthalmol. Ibero-Am.
*Ophthalmologia Ibero-Americana *(Brazil)*

Ophthalmologica
Ophthalmologica *(Switzerland)*

Opt. Acta
Optica Acta *(England)*

Optik
Optik *(Germany)*

Opt. i Spektroskopiya
Optika i Spektroskopiya† *(U.S.S.R.)*

Opt. Spectry. (USSR) (English Transl.)
*Optics and Spectroscopy (USSR) (English Translation of Optika i Spektroskopiya) *(U. S.)*

Oral Surg., Oral Med., Oral Pathol.
Oral Surgery, Oral Medicine, Oral Pathology *(U. S.)*

Orv. Hetilap
Orvosi Hetilap *(Hungary)*

Osaka City Med. J.
*Osaka City Medical Journal *(Japan)*

Osaka Furitsu Kogyo-Shoreikan Hokoku
Osaka Furitsu Kogyo-Shoreikan Hokoku (Reports of Industrial Research Institute, Osaka Prefecture) *(Japan)*

Osaka Shiritsu Daigaku Igaku Zasshi
*Osaka Shiritsu Daigaku Igaku Zasshi (The Journal of the Osaka City Medical Center) *(Japan)*

Osaka Shiritsu Daigaku Kaseigakubu Kiyo
Osaka Shiritsu Daigaku Kaseigakubu Kiyo (Reports of the Science of Living, Osaka City University) *(Japan)*

Osaka Shiritsu Kogyo Kenkyusho Hokoku
Osaka Shiritsu Kogyo Kenkyusho Hokoku (Bulletin of the Osaka Municipal Technical Research Institute) *(Japan)*

Osteuropa-Naturw.
Osteuropa-Naturwissenschaft *(Germany)*

Otolaryngology (Japan)
Otolaryngology (Japan)
see Jibi Inko-ka

Otorinolaringol. Ital.
Otorinolaringologia Italiana *(Italy)*

Oyo Butsuri
Oyo Butsuri (Journal of AppliedPhysics) *(Japan)*

Pacific Med. Surg.
Pacific Medicine and Surgery *(U. S.)*

Pakistan J. Sci. Ind. Res.
*Pakistan Journal of Scientific and Industrial Research *(Pakistan)*

Pakistan Med. J.
Pakistan Medical Journal *(Pakistan)*

Panminerva Med.
Panminerva Medica *(Italy)*

Panminerva Med. (English Ed.)
Panminerva Medica (English Edition) *(Italy)*

Papers Meteorol. Geophys. (Tokyo)
Papers in Meteorology and Geophysics (Tokyo) *(Japan)*

Parasitology
Parasitology *(England)*
Pathol. Biol. Semaine Hop.
*Pathologie et Biologie, Archives de Biologie Medicale, Annales de la Recherche Medicale, La Semaine des Hopitaux *(France)*
Pathol. Microbiol.
Pathologia et Microbiologia *(Switzerland)*
Pathologica
*Pathologica *(Italy)*
Patol. Fiziol. i Eksperim. Terapiya
Patologicheskaya Fiziologiya i Eksperimental'naya Terapiya *(U.S.S.R.)*
Patol. Polska
Patologia Polska *(Poland)*
Pediat. Clin. N. Am.
Pediatric Clinics of North America *(U. S.)*
Pediat. Pratica
*Pediatria Pratica *(Brazil)*
Pediatria (Santiago, Chile)
*Pediatria (Santiago, Chile) *(Chile)*
Pediatrics
Pediatrics *(U. S.)*
Pediatrie
Pediatrie *(France)*
Pedologie
Pedologie *(Belgium)*
Penn. Med. J.
Pennsylvania Medical Journal, The *(U. S.)*
Perceptual Motor Skills
Preceptual and Motor Skills *(U. S.)*
Perspectives Biol. Med.
*Perspectives in Biology and Medicine *(U. S.)*
Pest Control
Pest Control *(U. S.)*
Petrol. Chem. (USSR) (English Transl.)
Petroleum Chemistry (USSR) (English Translation of Neftekhimiya) *(U. S.)*
Pharm. Acta Helv.
Pharmaceutica Acta Helvetiae *(Switzerland)*
(Supplement to Schweizerische Apotheker-Zeitung)
Pharmazie
Pharmazie, Die *(Germany)*
Pharm. Rept. (Peking)
Pharmacy Reports (Peking)
see Yao Hsueh T'ung Pao
Pharm. Weekblad
Pharmaceutisch Weekblad *(Netherlands)*
Philips Res. Rept.
*Philips Research Reports *(Netherlands)*
Philips Tech. Rev.
*Philips Technical Review *(Netherlands)*
Phil. Mag.
*Philosophical Magazine, The *(England)*
Phil. Trans. Roy. Soc. London, Ser. A.
Philosophical Transactions of the Royal Society of London, Series A *(England)*
Phot. Korr.
Photographische Korrespondenz *(Austria)*
Photochem. Photobiol.
Photochemistry and Photobiology *(England)*
Phot. Sci. Eng.
*Photographic Science and Engineering *(U. S.)*
Phys. Can.
*Physics in Canada *(Canada)*
Phys. Chem. Glasses
Physics and Chemistry of Glasses *(England)*
Phys. Chem. Solids
Physics and Chemistry of Solids, The *(U. S.)*
Phys. Fluids
*Physics of Fluids, The *(U. S.)*
Physica
*Physica *(Netherlands)*
Physics
*Physics *(U. S.)*
Physik. Bl.
Physikalische Blaetter *(Germany)*
Physik Kondensierten Materie
*Physik der Kondensierten Materie *(Germany)*
Physik. Verhandl. DPG (Deut. Physik. Ges.)
Physikalische Verhandlungen DPG (Organ der Deutschen Physikalischen Gesellschaft) *(Germany)*
Physik. Z.
Physikalische Zeitschrift *(Germany)*
Physiol. Bohemoslov.
Physiologia Bohemoslovenica *(Czechoslovakia)*
Physiol. Plantarum
Physiologia Plantarum *(Denmark)*
Physiol. Rev.
Physiological Reviews *(U. S.)*
Physiol. Zool.
Physiological Zoology *(U. S.)*
Phys. Letters
*Physics Letters *(Netherlands)*
Phys. Med. Biol.
*Physics in Medicine and Biology *(England)*
Phys. Rev.
*Physical Review, The *(U. S.)*
Phys. Rev. Letters
*Physical Review Letters *(U. S.)*
Phys. Status Solidi
*Physica Status Solidi *(Germany)*
Phys. Today
*Physics Today *(U. S.)*
Phyton (Buenos Aires)
Phyton (Buenos Aires) *(Argentina)*
Phytopathology
Phytopathology *(U. S.)*
Planetary Space Sci.
*Planetary and Space Science *(England)*
Planseeber. Pulvermet.
*Planseeberichte fuer Pulvermetallurgie Vereinigt mit Powder Metallurgy Bulletin *(Austria)*
Planta
Planta *(Germany)*
Plant Physiol.
*Plant Physiology *(U. S.)*
Plant Soil
Plant and Soil *(Netherlands)*
Plasma Phys.-Accelerators-Thermonucl. Res., J. Nucl. Energy: Pt. C
Plasma Physics-Accelerators-Thermonuclear Research, Journal of Nuclear Energy: Part C
see J. Nucl. Energy: Pt. C
Plasticheskie Massy
Plasticheskie Massy† *(U.S.S.R.)*
Plastic Mater. (Tokyo)
Plastic Materials (Tokyo)
see Purasuchikku Zairyo
Plastic Reconstruct. Surg.
Plastic and Reconstructive Surgery and the Transplantation Bulletin *(U. S.)*
Pochvovedenie
Pochvovedenie† *(U.S.S.R.)*
Point Point Telecommun.
Point to Point Telecommunications *(England)*
Pokroky Mat. Fys. Astron.
*Pokroky Matematiky, Fysiky a Astronomie *(Czechoslovakia)*
Polar Record
Polar Record, The *(England)*
Polish Med. J.
Polish Medical Journal *(Poland)*
Polskie Arch. Med. Wewnetrznej
Polskie Archiwum Medycyny Wewnetrznej *(Poland)*
Polski Przeglad Radiol. i Med. Nuklearnej
*Polski Przeglad Radiologii i Medycyny Nuklearnej *(Poland)*
Polski Tygod. Lekar.
Polski Tygodnik Lekarski *(Poland)*
Polymer
*Polymer *(England)*
Poroshkovaya Met., Akad. Nauk Ukr. SSR
*Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR *(Ukrainian S.S.R.)*
Postepy Astron.
*Postepy Astronomii *(Poland)*
Postepy Biochem.
*Postepy Biochemii *(Poland)*
Postepy Fiz.
*Postepy Fizyki *(Poland)*
Postepy Hig. Med. Doswiadczalnej
*Postepy Higieny i Medycyny Doswiadczalnej *(Poland)*
Postepy Nauk Rolniczych
*Postepy Nauk Rolniczych *(Poland)*

Postgrad. Med.
Postgraduate Medicine *(U. S.)*

Postgrad. Med. J. (London)
Postgraduate Medical Journal (London) *(England)*

Poultry Sci.
Poultry Science *(U. S.)*

Poumon Coeur
Poumon et le Coeur *(France)*

Powder Met.
*Powder Metallurgy *(England)*

Power
*Power with which are consolidated Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer, and Operating Engineer *(U. S.)*

Power Eng.
Power Engineering *(U. S.)*

Power Reactor Technol.
*Power Reactor Technology (A Quarterly Technical Progress Review) *(U. S.)*

Poznan Towarz. Przyjaciol Nauk, Wydzial Lekar., Prace Komisji Med. Doswiadczalnej
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Medycyny Doswiadczalnej *(Poland)*

Prace Central. Inst. Ochrony Pracy
Prace Centralnego Instytutu Ochrony Pracy *(Poland)*

Prace Inst. Hutniczych
*Prace Instytutow Hutniczych *(Poland)*

Prace Inst. Maszyn Przeplywowych
Prace Instytutu Maszyn Przeplywowych *(Poland)*

Pracovni Lekar.
*Pracovni Lekarstvi *(Czechoslovakia)*

Practitioner
Practitioner, The *(England)*

Pract. Oto-Rhino-Laryngol.
Practica Oto-Rhino-Laryngologica *(Switzerland)*

Prakt. Metallog.
*Praktische Metallographie *(Germany)*

Praxis (Bern)
Praxis (Bern) *(Switzerland)*

Prensa Med. Arg.
Prensa Medica Argentina, La *(Argentina)*

Presse Med.
Presse Medicale, La *(France)*

Presse Thermale Climat.
Presse Thermale et Climatique *(France)*

Priborostroenie
Priborostroenie *(U.S.S.R.)*

Pribory i Metody Analiza Izluchenii, Mosk. Inzh. Fiz. Inst.
Pribory i Metody Analiza Izluchenii, Moskovskii Inzhenerno-Fizicheskii Institut *(U.S.S.R.)*

Pribory i Tekhn. Eksperim.
*Pribory i Tekhnika Eksperimenta† *(U.S.S.R.)*

Prikl. Mat. i Mekhan.
*Prikladnaya Matematika i Mekhanika† *(U.S.S.R.)*

Primena Radioaktiv. Izotopa i Jonizujucih Zracenja u Med.
*Primena Radioaktivnih Izotopa i Jonizujucih Zracenja u Medicini *(Yugoslavia)*

Priroda
*Priroda *(U.S.S.R.)*

Probl. Endokrinol. i Gormonoterap.
Problemy Endokrinologii i Gormonoterapii *(U.S.S.R.)*

Probl. Gematol. i Pereliv. Krovi
Problemy Gematologii i Perelivaniya Krovi *(U.S.S.R.)*

Probl. Kibernetiki
Problemy Kibernetiki† *(U.S.S.R.)*

Proc. Am. Power Conf.
Proceedings of the American Power Conference *(U. S.)*

Proc. Am. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*

Proc. Ann. Meeting New Jersey Mosquito Exterm. Assoc.
Proceedings of the Annual Meeting of the New Jersey Mosquito Extermination Association *(U. S.)*

Proc. Assoc. Clin. Biochemists
Proceedings of the Association of Clinical Biochemists *(England)*

Proc. Cambridge Phil. Soc.
*Proceedings of the Cambridge Philosophical Society (England)

Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964
Proceedings of the Conference on Remote Systems Technology, 12th [Conference], San Francisco, Nov. 30–Dec. 3, 1964 (formerly Hot Laboratories and Equipment Conference) *(U. S.)*

Proc. Congr. Intern. Federation Soc. Cosmet. Chemists, 2nd, London, 1962
Proceedings of the Congress of the International Federation of Societies of Cosmetic Chemists, 2nd Congress, London, July 2-5, 1962 (Pub. 1963) *(U. S.-England)*

[Proc.] European Regional Conf. Electron Microscopy, 3rd, Prague, 1963
[Proceedings] of the European Regional Conference on Electron Microscopy, 3rd [Conference], Prague, August 26–September 3, 1964 (Pub. 1964) *(Czechoslovakia)*

Proc. Fac. Eng. Tokai Univ.
Proceedings of the Faculty of Engineering of Tokai University *(Japan)*

Proc. Florida Mango Forum
Proceedings of the Florida Mango Forum *(U. S.)*

Proc. Fujihara Mem. Fac. Eng. Keio Univ. (Tokyo)
Proceedings of the Fujihara Memorial Faculty of Engineering, Keio University (Tokyo) *(Japan)*

Proc. Geol. Assoc. Can.
*Proceedings of the Geological Association of Canada *(Canada)*

Proc. IEEE (Inst. Elec. Electron. Engrs.)
*Proceedings of the IEEE (Institute of Electrical and Electronics Engineers) (formerly Proceedings of the Institute of Radio Engineers) *(U. S.)*

Proc. Indiana Acad. Sci.
*Proceedings of the Indiana Academy of Science *(U. S.)*

Proc. Indian Acad. Sci., Sect. A
*Proceedings of the Indian Academy of Sciences, Section A *(India)*

Proc. Inst. Elec. Engrs. (London)
*Proceedings of the Institution of Electrical Engineers, The (London) *(England)*

Proc. Inst. Mech. Engrs. (London)
Proceedings of the Institution of Mechanical Engineers (London) *(England)*

Proc. Inst. Med. Chicago
Proceedings of the Institute of Medicine of Chicago *(U. S.)*

Proc. Intern. Congr. Human Genet., 2nd, Rome, 1961
Proceedings of the International Congress of Human Genetics, 2nd Congress, Rome, Sept. 6-12, 1961 (Pub. 1963) *(Italy)*

Proc. Iowa Acad. Sci.
*Proceedings of the Iowa Academy of Science *(U. S.)*

Proc. Japan Acad.
Proceedings of the Japan Academy *(Japan)*

Proc. Leeds Phil. Lit. Soc., Sci. Sect.
*Proceedings of the Leeds Philosophical and Literary Society, Scientific Section *(England)*

Proc. Natl. Acad. Sci. U. S.
*Proceedings of the National Academy of Sciences of the United States of America *(U. S.)*

Proc. Natl. Inst. Sci. India. Pt. A
*Proceedings of the National Institute of Sciences of India. Part A *(India)*

Proc. Natl. Inst. Sci. India, Pt. B
*Proceedings of the National Institute of Sciences of India, Part B *(India)*

Proc. Nutr. Soc. (Engl.-Scot.)
Proceedings of the Nutrition Society (England and Scotland) *(England)*

Proc. Penn. Acad. Sci.
Proceedings of the Pennsylvania Academy of Science *(U. S.)*

Proc. Phys. Seminar Trondheim
Proceedings of the Physics Seminar in Trondheim
see Ark. Fys. Seminar Trondheim

Proc. Phys. Soc. (London)
*Proceedings of the Physical Society (London), The *(England)*

Proc. Phys. Soc. Japan
Proceedings of the Physical Society of Japan
see Nippon Butsuri Gakkaisi

Proc. Res. Inst. Nucl. Med. Biol.
*Proceedings of Research Institute for Nuclear Medicine and Biology *(Japan)*

Proc. Roy. Irish Acad., Sect. A
*Proceedings of the Royal Irish Academy, Section A *(Ireland)*

Proc. Roy. Soc. Edinburgh, A
*Proceedings of the Royal Society of Edinburgh, Section A *(Scotland)*

Proc. Roy. Soc. (London), Ser. A
*Proceedings of the Royal Society (London), Series A *(England)*

Proc. Roy. Soc. (London), Ser. B
*Proceedings of the Royal Society (London), Series B *(England)*
Proc. Roy. Soc. Med.
Proceedings of the Royal Society of Medicine *(England)*
Proc. Rudolf Virchow Med. Soc. City N. Y.
Proceedings of the Rudolf Virchow Medical Society in the City of New York *(Switzerland)*
Proc. S. Dakota Acad. Sci.
Proceedings of the South Dakota Academy of Science *(U. S.)*
Proc. Soc. Exptl. Biol. Med.
*Proceedings of the Society for Experimental Biology and Medicine *(U. S.)*
Proc. Vibration Probl.
*Proceedings of Vibration Problems *(Poland)*
Proc. Western Pharmacol. Soc.
Proceedings of the Western Pharmacology Society *(U. S.)*
Proc. Zool. Soc. London
Proceedings of the Zoological Society of London *(England)*
Prod. Finishing (Cincinnati)
Products Finishing (Cincinnati) *(U. S.)*
Progr. Astronaut. Aeronaut.
*Progress in Astronautics and Aeronautics *(U. S.)*
Progr. Biophys. Mol. Biol.
Progress in Biophysics and Molecular Biology (formerly Progress in Biophysics and Biophysical Chemistry) *(U. S.)*
Progr. Cardiovascular Diseases
Progress in Cardiovascular Diseases *(U. S.)*
Progr. Clin. Cancer
Progress in Clinical Cancer *(U. S.)*
Progr. Cryog.
*Progress in Cryogenics *(England)*
Progr. Elem. Particle Cosmic Ray Phys.
*Progress in Elementary Particle and Cosmic Ray Physics *(U. S.–Netherlands)*
Progr. Hematol.
Progress in Hematology *(U. S.)*
Progr. Inorg. Chem.
*Progress in Inorganic Chemistry *(U. S.)*
Progr. Mater. Sci.
Progress in Materials Science *(England)*
Progr. Med. (Naples)
Progresso Medico (Naples), II *(Italy)*
Progr. Med. (Paris)
Progres Medical (Paris) *(France)*
Progr. Med. Genet.
Progress in Medical Genetics *(U. S.)*
Progr. Med. Virol.
Progress In Medical Virology *(Switzerland)*
Progr. Nucleic Acid Res.
*Progress in Nucleic Acid Research *(U. S.)*
Progr. Nucl. Energy, Ser. I
*Progress in Nuclear Energy, Series I *(England–U. S.)*
Progr. Nucl. Energy, Ser. II
*Progress in Nuclear Energy, Series II *(England–U. S.)*
Progr. Nucl. Energy, Ser. V
*Progress in Nuclear Energy, Series V *(England–U. S.)*
Progr. Nucl. Energy, Ser. VIII
*Progress in Nuclear Energy, Series VIII *(England–U. S.)*
Progr. Nucl. Energy, Ser. X
*Progress in Nuclear Energy, Series X *(England–U. S.)*
Progr. Nucl. Phys.
*Progress in Nuclear Physics *(U. S.)*
Progr. Powder Met.
Progress in Powder Metallurgy *(U. S.)*
Progr. Radiation Therapy
Progress in Radiation Therapy *(U. S.)*
Progr. Reaction Kinetics
*Progress in Reaction Kinetics *(U. S.)*
Progr. Sci. Technol. Rare Earths
*Progress in the Science and Technology of the Rare Earths *(U. S.)*
Progr. Stereochem.
*Progress in Stereochemistry *(U. S.)*
Progr. Theoret. Phys. (Kyoto)
*Progress of Theoretical Physics (Kyoto) *(Japan)*
Progr. Theoret. Phys. (Kyoto), Suppl.
*Progress of Theoretical Physics (Kyoto), Supplement *(Japan)*
Protect., Securite, Hyg. Trav.
Protection, Securite, Hygiene du Travail *(France)*
Protides Biol. Fluids, Proc. Colloq.
*Protides of the Biological Fluids, Proceedings of the Colloquium *(Belgium)*

Protoplasma
Protoplasma *(Austria)*
Prumysl Potravin
Prumysl Potravin *(Czechoslovakia)*
Przeglad Dermatol.
Przeglad Dermatologiczny *(Poland)*
Przeglad Elektron.
*Przeglad Elektroniki *(Poland)*
Przeglad Elektrotech.
Przeglad Elektrotechniczny *(Poland)*
Przeglad Geofiz.
*Przeglad Geofizyczny *(Poland)*
Przeglad Geol.
*Przeglad Geologiczny *(Poland)*
Przeglad Odlewnictwa
*Przeglad Odlewnictwa *(Poland)*
Przeglad Tech.
Przeglad Techniczny *(Poland)*
Przemysl Chem.
*Przemysl Chemiczny *(Poland)*
Psychiat. Neurol. Neurochir.
Psychiatria, Neurologia, Neurochirurgia *(Netherlands)*
Psychol. Bull.
Psychological Bulletin *(U. S.)*
Psychol. Rept.
Psychological Reports *(U. S.)*
Publ. Astron. Soc. Japan
Publications of the Astronomical Society of Japan *(Japan)*
Public Health Eng. Abstr.
*Public Health Engineering Abstracts *(U. S.)*
Public Health Rept. (U. S.)
*Public Health Reports *(U. S.)*
Public Works
Public Works, City, County and State *(U. S.)*
Publ. Lab. Fis. Cosmica, Univ. Mayor San Andres
*Publicaciones del Laboratorio de Fisica Cosmica, Universidad Mayor de San Andres *(Bolivia)*
Publ. Univ. Offic. Congo Elisabethville
Publications de l'Universite Officielle du Congo a Elisabethville *(Congo (Leopoldville))*
Purasuchikku Zairyo
Purasuchikku Zairyo (Plastic Materials) *(Japan)*
Pure Appl. Chem.
*Pure and Applied Chemistry (The Official Journal of the International Union of Pure and Applied Chemistry) *(U. S.)*
Pure Appl. Geophys.
*Pure and Applied Geophysics (formerly Geofizika Pura e Aplicata) *(Switzerland)*
Quaderni Clin. Obstet. Ginecol.
Quaderni di Clinica Obstetrica e Ginecologica *(Italy)*
Quaderni Radiol.
Quaderni di Radiologia *(Italy)*
Quart. Appl. Math.
*Quarterly of Applied Mathematics *(U. S.)*
Quart. J. Med.
Quarterly Journal of Medicine, The *(England)*
Quart. J. Roy. Astron. Soc.
*Quarterly Journal of the Royal Astronomical Society, The *(England)*
Quart. Rev. (London)
*Quarterly Reviews (London) *(England)*
Queensland J. Agr. Animal Sci.
*Queensland Journal of Agricultural and Animal Science (formerly Queensland Journal of Agricultural Science) *(Australia)*
Radiation Botany
*Radiation Botany *(England)*
Radiation Res.
*Radiation Research *(U. S.)*
Radiats. Fiz., Akad. Nauk Latv. SSR, Inst. Fiz.
Radiatsionnaya Fizika, Akademiya Nauk Latviiskoi SSR, Institut Fiziki *(Latvian S.S.R.)*
Radiazioni Alta Energia
Radiazioni di Alta Energia *(Italy)*
Radioact. Sea
*Radioactivity in the Sea *(Austria)*
Radioaktivni Izotopi i Zracenja
Radioaktivni Izotopi i Zracenja *(Yugoslavia)*
Radiobiol. Latina
*Radiobiologica Latina *(Italy)*
Radiobiologiya
*Radiobiologiya† *(U.S.S.R.)*

Radiobiol. Radioterap. Fis. Med.
*Radiobiologia, Radioterapia e Fisica Medica (formerly Radioterapia, Radiobiologia e Fisica Medica) *(Italy)*

Radiobiol.-Radiotherap.
*Radiobiologia--Radiotherapie *(Germany)*

Radiocarbon
*Radiocarbon *(U. S.)*

Radiochim. Acta
*Radiochimica Acta *(Germany)*

Radio Electron. Engr.
Radio and Electronic Engineer, The *(England)*

Radiography
Radiography *(England)*

Radioisotopes (Tokyo)
*Radioisotopes (Tokyo) *(Japan)*

Radiokhimiya
*Radiokhimiya† *(U.S.S.R.)*

Radiol. Austriaca
Radiologia Austriaca *(Austria)*

Radiol. Clin.
Radiologia Clinica *(Switzerland)*

Radiol. Clin. Biol.
*Radiologia Clinica et Biologica (formerly Radiologia Clinica) *(Switzerland)*

Radiol. Clin. N. Am.
Radiologic Clinics of North America *(U. S.)*

Radiol. Diagn.
*Radiologia Diagnostica *(Germany)*

Radiol. Health Data
*Radiological Health Data *(U. S.)*

Radiol. Med.
*Radiologia Medica, La *(Italy)*

Radiologe
Radiologe *(Germany)*

Radiologia (Panama)
Radiologia *(Panama)*

Radiology
*Radiology *(U. S.)*

Radiol. Technol.
Radiologic Technology (formerly X-Ray Technician) *(U. S.)*

Radiotekhn. i Elektron.
*Radiotekhnika i Elektronika† *(U.S.S.R.)*

Rare Metals (Tokyo)
Rare Metals (Tokyo)
see Kogyo Reametaru

Rass. Chim.
Rassegna Chimica *(Italy)*

Rass. Clin.-Sci. Ist. Biochim. Ital.
Rassegna Clinico-Scientifica dell'Istituto Biochimico Italiano *(Italy)*

Rass. Med. Ind.
Rassegna di Medicina Industriale *(Italy)*

Rass. Med. Sper.
Rassegna di Medicina Sperimentale *(Italy)*

Rass. Neurol. Vegetativa
Rassegna di Neurologia Vegetativa *(Italy)*

Raumfahrtforschung
*Raumfahrtforschung (formerly Raketentechnik und Raumfahrtforschung) *(Germany)*

RCA Engr.
RCA Engineer *(U. S.)*

RCA Rev.
*RCA Review *(U. S.)*

Reactor Fuel Process.
*Reactor Fuel Processing (A Quarterly Technical Progress Review) *(U. S.)*

Reactor Mater.
*Reactor Materials (A Quarterly Technical Progress Review) *(U. S.)*

Reactor Sci. Technol., J. Nucl. Energy: Pt. A & B
Reactor Science and Technology, Journal of Nuclear Energy: Parts A & B
see J. Nucl. Energy: Pt. A & B

Rech. Aerospatiale
Recherche Aerospatiale, La *(France)*

Rec. Trav. Chim.
*Recueil des Travaux Chimiques des Pays-Bas *(Netherlands)*

Rehabilitation (Bonn)
Rehabilitation (Bonn) *(Germany)*

Rend. Ist. Lombardo Sci. Lettere, B
Rendiconti dell'Istituto Lombardo di Scienze e Lettere, B *(Italy)*

Rend. Ist. Super. Sanita
Rendiconti Istituto Superiore di Sanità *(Italy)*

Rept. Army Res. Testing Lab.
*Report of the Army Research and Testing Laboratory *(Korea)*

Rept. Ferment. Res. Inst.
Report of the Fermentation Research Institute
see Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku

Rept. Govt. Chem. Ind. Res. Inst., Tokyo
Reports of the Government Chemical Industrial Research Institute, Tokyo
see Tokyo Kogyo Shikensho Hokoku

Rept. Govt. Ind. Res. Inst., Nagoya
Reports of the Government Industrial Research Institute, Nagoya
see Nagoya Kogyo Gijutsu Shikensho Hokoku

Rept. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Institute, Osaka Prefecture
see Osaka Furitsu Kogyo-Shoreikan Hokoku

Rept. Inst. Phys. Chem. Res. (Tokyo)
Reports of the Institute of Physical and Chemical Research (Tokyo)
see Rika Gaku Kenkyusho Hokoku

Rept. Ionosphere Space Res. Japan
*Report of Ionosphere and Space Research in Japan *(Japan)*

Rept. Kihara Inst. Biol. Res.
Reports of the Kihara Inst. for Biological Research
see Seiken Jiho

Rept. Liberal Arts Sci. Faculty Shizuoka Univ., Nat. Sci.
Reports of Liberal Arts and Science Faculty Shizuoka University, Natural Science *(Japan)*

Rept. Progr. Appl. Chem.
Reports on the Progress of Applied Chemistry *(England)*

Rept. Progr. Phys.
*Reports on Progress in Physics *(England)*

Rept. Res. Inst. Elec. Commun., Tohoku Univ.
*Reports of the Research Institute of Electrical Communication, Tohoku University, The *(Japan)*

Rept. Res. Lab. Surface Sci., Fac. Sci., Okayama Univ.
Reports of the Research Laboratory for Surface Science, Faculty of Science, Okayama University *(Japan)*

Rept. Sci. Living, Osaka City Univ.
Reports of the Science of Living, Osaka City University
see Osaka Shiritsu Daigaku Kaseigakubu Kiyo

Rept. Statist. Appl. Res., Union Japan. Scientists Engrs.
Reports of Statistical Application Research, Union of Japanese Scientists and Engineers *(Japan)*

Res. Develop. Associates Activities Rept.
Research and Development Associates, Inc. Activities Report *(U. S.)*

RES; J. Reticuloendothelial Soc.
RES; Journal of the Reticuloendothelial Society
see J. Reticuloendothelial Soc.

Res. Reactor J.
*Research Reactor Journal *(U. S.)*

Res. Rept. Fac. Eng., Niigata Univ.
Research Reports of the Faculty of Engineering, Niigata University
see Niigata Daigaku Kogakubu Kenkyu Hokoku

Res. Rev. (Office Aerospace Res.)
*Research Review (Office of Aerospace Research) *(U. S.)*

Reumatismo
*Reumatismo *(Italy)*

Rev. Aluminium
Revue de l'Aluminium *(France)*

Rev. Arg. Alergia
*Revista Argentina de Alergia *(Argentina)*

Rev. Arg. Anestesiol.
*Revista Argentina de Anestesiologia *(Argentina)*

Rev. Arg. Tuberc. Enfermedades Pulmonares
*Revista Argentina de Tuberculosis y Enfermedades Pulmonares *(Argentina)*

Rev. Arg. Urol.
Revista Argentina de Urologia *(Argentina)*

Rev. Asoc. Med. Arg.
Revista de la Asociacion Medica Argentina *(Argentina)*

Rev. Asoc. Med. Rio Grande do Sul
*Revista da Asociacao Medica do Rio Grande do Sul *(Brazil)*

Rev. At. Ind. (Tokyo)
Review of Atomic Industries (Tokyo)
see Genshiryoku Chose Jiho

Rev. Belge Pathol. Med. Exptl.
*Revue Belge de Pathologie et de Medecine Experimentale *(Belgium)*

Rev. Brasil. Cirurg.
Revista Brasileira de Cirurgia *(Brazil)*

Rev. Brasil. Gastroenterol.
*Revista Brasileira de Gastroenterologia *(Brazil)*

Rev. Can. Biol.
*Revue Canadienne de Biologie *(Canada)*

Rev. Chilena Pediat.
*Revista Chilena de Pediatria *(Chile)*

Rev. Chim. (Bucharest)
Revista de Chimie (Bucharest) *(Romania)*

Rev. Chim., Acad. Rep. Populaire Roumaine
Revue de Chimie, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Clin. Espan.
Revista Clinica Espanola *(Spain)*

Rev. Col. Med. Guatemala
*Revista del Colegio Medico de Guatemala *(Guatemala)*

Rev. Cubana Cardiol.
*Revista Cubana de Cardiologia *(Cuba)*

Rev. Cytol. Biol. Vegetales
Revue de Cytologie et de Biologie Vegetales *(France)*

Rev. Elec. Commun. Lab. (Tokyo)
Review of the Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation (Tokyo) *(Japan)*

Rev. Electrotech. Energet., Acad. Rep. Populaire Roumaine
*Revue d'Electrotechnique et d'Energetique, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Espan. Fisiol.
*Revista Espanola de Fisiologia *(Spain)*

Rev. Espan. Oto-neuro-oftalmol. Neurocir.
*Revista Espanola de Oto-neuro-oftalmologia y Neurocirugia *(Spain)*

Rev. Espan. Reumat. Enfermedades Osteoarticulares
*Revista Espanola de Reumatismo y Enfermedades Osteo-articulares *(Spain)*

Rev. Espan. Tuberc.
*Revista Espanola de Tuberculosis y Archivos Nacionales de Enfermedades del Torax *(Spain)*

Rev. Franc. Etudes Clin. Biol.
*Revue Francaise d'Etudes Cliniques et Biologiques *(France)*

Rev. Franc. Gynecol. Obstet.
Revue Francaise de Gynecologie et d'Obstetrique *(France)*

Rev. Gen. Elec.
*Revue Generale de l'Electricite *(France)*

Rev. Gen. Electron.
Revue Generale d'Electronique *(France)*

Rev. Gen. Mecan.
Revue Generale de Mecanique *(France)*

Rev. Geophys.
*Reviews of Geophysics *(U. S.)*

Rev. Ginecol. Obstet. (Rio de Janeiro)
*Revista de Ginecologia e d'Obstetricia (Rio de Janeiro) *(Brazil)*

Rev. Goiana Med.
*Revista Goiana de Medicina *(Brazil)*

Rev. Hautes Temp. Refractaires
*Revue des Hautes Temperatures et des Refractaires *(France)*

Rev. Hosp. Clin., Fac. Med., Univ. Sao Paulo
*Revista do Hospital das Clinicas, Faculdade de Medicina, Universidade de Sao Paulo *(Brazil)*

Rev. Hosp. Nino (Lima)
*Revista del Hospital del Nino (Lima) *(Peru)*

Rev. Hosp. San Juan de Dios (Bogota)
*Revista del Hospital de San Juan de Dios (Bogota) *(Colombia)*

Rev. Hyg. Med. Sociale
Revue d'Hygiene et de Medecine Sociale *(France)*

Rev. Iberica Endocrinol.
*Revista Iberica de Endocrinologia *(Spain)*

Rev. Immunol.
*Revue d'Immunologie et de Therapie Antimicrobienne *(France)*

Rev. Inst. Ing. Elec.
*Revista del Instituto de Ingenieria Electrica *(Argentina)*

Rev. Inst. Med. Trop. Sao Paulo
*Revista do Instituto de Medicina Tropical de Sao Paulo *(Brazil)*

Rev. Invest. Clin. Organo Hosp. Enfermedades Nutr. Mex.
*Revista de Investigacion Clinica, Organo del Hospital de Enfermedades de la Nutricion, Mexico *(Mexico)*

Rev. Latinoam. Anat. Patol.
*Revista Latinoamericana de Anatomia Patologica *(Venezuela)*

Rev. Latino-Am. Cir. Plastica
*Revista Latinoamericana de Cirugia Plastica *(Mexico)*

Rev. Latinoam. Microbiol.
*Revista Latinoamericana de Microbiologia *(Mexico)*

Rev. Leprol. (Fontilles)
*Revista de Leprologia (Fontilles) *(Spain)*

Rev. Lyon. Med.
Revue Lyonnaise de Medecine, La *(France)*

Rev. M.B.L.E.
*Revue de Manufacture Belge de Lampes et de Materiel *(Belgium)*

Rev. Med. Aeron. (Paris)
Revue de Medecine Aeronautique (Paris) *(France)*

Rev. Med. Aeron. (Rio de Janeiro)
*Revista Medica da Aeronautica (Rio de Janeiro) *(Brazil)*

Rev. Med. Cordoba
*Revista Medica de Cordoba *(Argentina)*

Rev. Med. Hosp. Colonia (Mex.)
*Revista Medica del Hospital Colonia *(Mexico)*

Rev. Med. Hosp. Espan. (Mex.)
*Revista Medica del Hospital Espanol *(Mexico)*

Rev. Med. Hosp. Gen. (Mex.)
Revista Medica del Hospital General *(Mexico)*

Rev. Med. Hosp. Obrero (Lima)
*Revista Medica del Hospital Obrero (Lima) *(Peru)*

Rev. Med. Liege
Revue Medicale de Liege *(Belgium)*

Rev. Med. Moyen-Orient
Revue Medicale du Moyen-Orient *(France)*

Rev. Med. Rio Grande do Sul
*Revista de Medicina do Rio Grande do Sul *(Brazil)*

Rev. Med. Suisse Romande
Revue Medicale de la Suisse Romande *(Switzerland)*

Rev. Med. Valparaiso
*Revista Medica de Valparaiso *(Chile)*

Rev. Met. (Paris)
*Revue de Metallurgie (Paris) *(France)*

Rev. Metal Lit.
*Review of Metal Literature *(U. S.)*

Rev. Mex. Cienc. Med. Biol.
*Revista Mexicana de Ciencias Medicas y Biologicas *(Mexico)*

Rev. Mex. Cir. Ginecol. Cancer
*Revista Mexicana de Cirugia, Ginecologia y Cancer *(Mexico)*

Rev. Mex. Fis.
*Revista Mexicana de Fisica *(Mexico)*

Rev. Mex. Tuberc. Aparato Respirat.
*Revista Mexicana de Tuberculosis y Aparato Respiratorio *(Mexico)*

Rev. Mod. Phys.
*Reviews of Modern Physics *(U. S.)*

Rev. Neurol.
Revue Neurologique *(France)*

Rev. Neurol. Buenos Aires
*Revista Neurologica de Buenos Aires *(Argentina)*

Rev. Obstet. Ginecol. (Caracas)
*Revista de Obstetricia y Ginecologia (Caracas) *(Venezuela)*

Rev. Opt.
Revue d'Optique, Theorique et Instrumentale *(France)*

Rev. Ortoped. Traumatol. Latinoam.
*Revista de Ortopedia y Traumatologia Latinoamericana *(Argentina)*

Rev. Otorinolaringol. (Santiago, Chile)
*Revista de Otorrinolaringologia (Santiago, Chile) *(Chile)*

Rev. Paulista Med.
Revista Paulista de Medicina *(Brazil)*

Rev. Phys., Acad. Rep. Populaire Roumaine
*Revue de Physique, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Phys. Chem. Japan
Review of Physical Chemistry of Japan, The *(Japan)*

Rev. Port. Quim. (Lisbon)
*Revista Portuguesa de Quimica (Lisbon) *(Portugal)*

Rev. Praticien
Revue du Praticien *(France)*

Rev. Psiquiat. (Santiago, Chile)
*Revista de Psiquiatria (Santiago, Chile) *(Chile)*

Rev. Psiquiat. Peruana
*Revista Psiquiatrica Peruana *(Peru)*

Rev. Pure Appl. Chem.
*Reviews of Pure and Applied Chemistry *(Australia)*

Rev. Questions Sci.
Revue des Questions Scientifiques *(Belgium)*

Rev. Rhumat.
*Revue du Rhumatisme et des Maladies Osteo-Articulaires *(France)*

Rev. Roumaine Biochim.
Revue Roumaine de Biochimie *(Romania)*

Rev. Roumaine Chim.
*Revue Roumaine de Chimie (continuation of Revue de Chimie, Academie de la Republique Populaire Roumaine) *(Romania)*

Rev. Roumaine Phys.
Revue Roumaine de Physique *(Romania)*

Rev. Roumaine Physiol.
Revue Roumaine de Physiologie *(Romania)*

Rev. Roumaine Sci. Tech., Ser. Electrotech. Energ.
Revue Roumaine des Sciences Techniques, Serie Electrotechnique et Energetique *(Romania)*

Rev. Sanidad Hig. Publica
Revista de Sanidad e Higiene Publica *(Spain)*

Rev. Sanit. Mil.
Revista Sanitara Militara *(Romania)*

Rev. Sci. Instr.
*Review of Scientific Instruments, The *(U. S.)*

Rev. Sci. Med., Acad. Rep. Populaire Roumaine
Revue des Sciences Medicales, Academia de la Republique Populaire Roumaine *(Romania)*

Rev. Soc. Arg. Biol.
Revista de la Sociedad Argentina de Biologia *(Argentina)*

Rev. Soc. Med.-Quir. Zulia
*Revista de la Sociedad Medico-Quirurgica del Zulia *(Venezuela)*

Rev. Trav. Inst. Peches Maritimes
Revue des Travaux, Institut des Peches Maritimes *(France)*

Rev. Tuberc. (Paris)
Revue de la Tuberculose (Paris) *(France)*

Rev. Union Mat. Arg. Asoc. Fis. Arg.
*Revista de la Union Matematica Argentina y de la Asociacion Fisica Argentina *(Argentina)*

Rev. Univ. Ind. Santander
*Revista de la Universidad Industrial de Santander *(Colombia)*

Rev. Urol. (Caracas)
*Revista de Urologia (Caracas) *(Venezuela)*

Rev. Urol. (Mex.)
*Revista de Urologia *(Mexico)*

Rev. Venezolana Urol.
Revista Venezolana de Urologia *(Venezuela)*

Rheumatism
*Rheumatism *(England)*

Ric. Sci. Rend., Sez. A
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione A, Abiologica *(Italy)*

Ric. Sci. Rend., Sez. B
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione B, Biologica *(Italy)*

Riforma Med.
Riforma Medica, La *(Italy)*

Rika Gaku Kenkyusho Hokoku
*Rika Gaku Kenkyusho Hokoku (Reports of the Institute of Physical and Chemical Research) *(Japan)*

Rinsho Hoshasen
Rinsho Hoshasen (Clinical Radiology) *(Japan)*

Rinsho Ketsueki
Rinsho Ketsueki (The Japanese Journal of Clinical Hematology) *(Japan)*

Riv. Anat. Patol. Oncol.
Rivista di Anatomia Patologica e di Oncologia *(Italy)*

Riv. Biol.
Rivista di Biologia (Pubblicata a Cura dell'Istituto di Biologia Generale dell'Universita di Perugia) *(Italy)*

Riv. Clin. Pediat.
*Rivista di Clinica Pediatrica *(Italy)*

Riv. Infortuni Mal. Profess.
Rivista degli Infortuni e delle Malattie Professionali *(Italy)*

Riv. Ing. Nucl.
*Rivista di Ingegneria Nucleare *(Italy)*

Riv. Ist. Sieroterap. Ital.
*Rivista dell'Istituto Sieroterapico Italiano *(Italy)*

Riv. Ital. Igiene
Rivista Italiana d'Igiene *(Italy)*

Riv. Ital. Saldatura
Rivista Italiana della Saldatura *(Italy)*

Riv. Med. Aeron. Spaziale
Rivista di Medicina Aeronautica e Spaziale *(Italy)*

Riv. Neurol.
Rivista di Neurologia *(Italy)*

Rivoluzione Ind.
*Rivoluzione Industriale *(Italy)*

Riv. Ostet. Ginecol.
Rivista di Ostetricia e Ginecologia *(Italy)*

Riv. Ostet. Ginecol. Prat.
Rivista d'Ostetricia e Ginecologia Pratica *(Italy)*

Riv. Patol. Clin.
Rivista di Patologia e Clinica *(Italy)*

Riv. Patol. Nervosa Mentale
Rivista di Patologia Nervosa e Mentale *(Italy)*

Riv. Storia Med.
Rivista di Storia della Medicina *(Italy)*

Rocky Mt. Med. J.
Rocky Mountain Medical Journal *(U. S.)*

Roczniki Chem.
*Roczniki Chemii *(Poland)*

Roczniki Panstwowego Zakladu Hig.
*Roczniki Panstwowego Zakladu Higieny *(Poland)*

Roentgen Bl.
Roentgen Blaetter *(Germany)*

Roentgen-Lab. Praxis
Roentgen- und Laboratoriums Praxis *(Germany)*

Roentgenpraxis
Roentgenpraxis (continues in part Roentgen und Laboratoriums Praxis) *(Germany)*

Roy. Soc. Health J.
Royal Society of Health Journal *(England)*

Rozhledy Tuberk.
Rozhledy v Tuberkulose a Nemocech Plicnich *(Czechoslovakia)*

Rozpravy Cesk. Akad. Ved, Rada Mat. Prirod. Ved
Rozpravy Ceskoslovenske Akademie Ved, Rada Matematickych a Prirodnich Ved *(Czechoslovakia)*

Rozprawy Elektrotech.
*Rozprawy Elektrotechniczne *(Poland)*

Rubber Chem. Technol.
Rubber Chemistry and Technology *(U. S.)*

Rudy Metale Niezelazne
*Rudy i Metale Niezelazne *(Poland)*

Rumanian Med. Rev.
*Rumanian Medical Review *(Romania)*

S. African J. Agr. Sci.
South African Journal of Agricultural Science *(S. Africa)*

S. African J. Radiol.
*South African Journal of Radiology *(S. Africa)*

S. African Med. J.
South African Medical Journal *(S. Africa)*

S. African Mining Eng. J.
South African Mining and Engineering Journal *(S. Africa)*

Saiko To Hoan
Saiko To Hoan (Mining and Safety) *(Japan)*

Sanfujinka No Sekai
Sanfujinka No Sekai (The World of Obstetrics and Gynecology) *(Japan)*

Sanfujinka no Shimpo
Sanfujinka no Shimpo (Advances in Obstetrics and Gynaecology) *(Japan)*

Sangre
Sangre *(Spain)*

Santo Tomas J. Med.
*Santo Tomas Journal of Medicine *(Philippines)*

Saopstenja Inst. Vodoprivredu "Jaroslav Cerni"
Saopstenja Instituta za Vodoprivredu "Jaroslav Cerni" *(Yugoslavia)*

Sb. Lekar.
Sbornik Lekarsky *(Czechoslovakia)*

Sb. Nauchn.-Tekhn. Tr., Nauchn.-Issled. Inst. Met. Chelyabinsk. Sovnarkhoza
Sbornik Nauchno-Tekhnicheskikh Trudov, Nauchno-Issledovatel'skii Institut Metallurgii Chelyabinskogo Sovnarkhoza *(U.S.S.R.)*

Sb. Nauchn. Tr. Dnepropetr. Inzh.-Stroit. Inst.
Sbornik Nauchnykh Trudov, Dnepropetrovskii Inzhenerno-Stroitel'nyi Institut *(Ukrainian S.S.R.)*

Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR
*Sbornik Nauchnykh Trudov Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR (formerly Sbornik Nauchnykh Rabot

Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR) *(Ukrainian S.S.R.)*

Sb. Prac Lekar. Fak. Univ. P. J. Safarika Kosiciach
Sbornik Prac Lekarskej Fakulty Univerzity P. J. Safarika v Kosiciach *(Czechoslovakia)*

Sb. Rabot po Nekotorym Vopr. Dozimetr. i Radiometr. Ionizir. Izluchenii
Sbornik Rabot po Nekotorym Voprosma Dozimetrii i Radiometrii Ioniziruyushchika Izluchenii *(U.S.S.R.)*

Sb. Statei Obshch. Khim., Akad. Nauk SSSR
Sbornik Statei po Obshchei Khimii, Akademiya Nauk SSSR *(U.S.S.R.)*

Sb., Teoriya i Prakt. Stomatologii
Sbornik, Teoriya i Praktika Stomatologii *(U.S.S.R.)*

Sb. Tr. Leningr. Mekhan. Inst.
Sbornik Trudov Leningradskogo Mekhanicheskogo Instituta *(U.S.S.R.)*

Sb. Tr. Sverdlovsk. Gos. Med. Inst.
Sbornik Trudov Sverdlovskogo Gosudarstvennogo Meditsinskogo Instituta *(U.S.S.R.)*

Sb. Tr. Tsentr. Nauchn.-Issled. Inst. Chernoi Met.
Sbornik Trudov Tsentral'nogo Nauchno-Issledovatel'skogo Instituta Chernoi Metallurgii *(U.S.S.R.)*

Sb. Tr. Visshiya Med. Inst. "I. P. Pavlov"
Sbornik Trudove na Visshiya Meditsinski Institut "I. P. Pavlov" *(Bulgaria)*

Sb. Tr., Vses. Nauchn.-Issled. Inst. Tverd. Splavov
Sbornik Trudov, Vsesoyuznyi Nauchno-Issledovatel'skii Institut Tverdykh Splavov *(U.S.S.R.)*

Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove
*Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove *(Czechoslovakia)*

Scand. J. Clin. Lab. Invest.
Scandinavian Journal of Clinical & Laboratory Investigation *(Denmark)*

Scand. J. Haematol.
*Scandinavian Journal of Haematology *(Denmark)*

Schmiertechnik
Schmiertechnik *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Forsch. Bild.
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Forschung und Bildung *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Kernenergierecht
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Kernenergierecht (formerly Schriftenreihe des Bundesministers fuer Atomkernenergie und Wasserwirtschaft, Kernenergierecht) *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Radionuklide
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Radionuklide *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich)
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Strahlenschutz (Munich) *(Germany)*

Schweiz. Arch. Angew. Wiss. Tech.
*Schweizer Archiv fuer Angewandte Wissenschaft und Technik *(Switzerland)*

Schweiz. Bl. Arbeitssicherheit
Schweizerische Blaetter fuer Arbeitssicherheit *(Switzerland)*

Schweiz. Med. Wochschr.
Schweizerische Medizinische Wochenschrift *(Switzerland)*

Schweiz. Tech. Z.
Schweizerische Technische Zeitschrift *(Switzerland)*

Sci. Am.
*Scientific American *(U. S.)*

Sci. Basis Med., Ann. Rev.
Scientific Basis of Medicine, Annual Reviews (formerly Lectures on the Scientific Basis of Medicine) *(England)*

Sci. Cult. (Calcutta)
Science and Culture (Calcutta) *(India)*

Science
*Science *(U. S.)*

Sci. Eng. Rev. Doshisha Univ.
Science and Engineering Review of the Doshisha University *(Japan)*

Scientia (Milan)
Scientia (Milan) *(Italy)*

Scientia (Peking)
Scientia (Peking)
see K'o Hsueh T'ung Pao

Scientia (Valparaiso, Chile)
*Scientia (Valparaiso, Chile) *(Chile)*

Scientist Citizen
Scientist and Citizen (formerly Nuclear Information) *(U. S.)*

Sci. J.
*Science Journal *(England)*

Sci. Machine (Tokyo)
Science of Machine (Tokyo)
see Kikai No Kenkyu

Sci. Papers Coll. Gen. Educ., Univ. Tokyo
*Scientific Papers of the College of General Education, University of Tokyo *(Japan)*

Sci. Papers Inst. Phys. Chem. Res. (Tokyo)
*Scientific Papers of the Institute of Physical and Chemical Research (Tokyo) (formerly Journal of the Scientific Research Institute (Tokyo)) *(Japan)*

Sci. Pharm.
Scientia Pharmaceutica *(Austria)*

Sci. Proc. Roy. Dublin Soc., Ser. A
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*

Sci. Progr. (London)
*Science Progress (London) *(England)*

Sci. Progr.-Nature
*Science Progres--La Nature *(France)*

Sci. Publ. Fuji Photo Film Co., Ltd.
Scientific Publications of the Fuji Photo Film Co., Ltd. *(Japan)*

Sci. Rept. Fac. Agr. Ibaraki Univ.
Scientific Reports of the Faculty of Agriculture, Ibaraki University
see Ibaraki Daigaku Nogakubu Gakujitsu Hokoku

Sci. Rept. Ist. Super Sanita
Scientific Reports of the Istituto Superiore di Sanita (formerly Selected Scientific Papers from the Istituto Superiore di Sanita) *(Netherlands)*

Sci. Rept. Res. Inst. Theoret. Phys., Hiroshima Univ.
*Scientific Reports of the Research Institute for Theoretical Physics, Hiroshima University *(Japan)*

Sci. Rept. Res. Inst., Tohoku Univ., Ser. A
*Scientific Reports of the Research Institutes, The, Tohoku University, Series A *(Japan)*

Sci. Rept. Res. Inst., Tohoku Univ., Ser. B
Science Reports of the Research Institutes, The, Tohoku University, Series B *(Japan)*

Sci. Rept. Res. Inst., Tohoku Univ., Ser. C
Science Reports of the Research Institutes, The, Tohoku University, Series C *(Japan)*

Sci. Rept. Saitama Univ., Ser. A
*Science Reports of Saitama University, The, Series A *(Japan)*

Sci. Rept. Tohoku Univ., Fifth Ser.
Science Reports of the Tohoku University, Fifth Series *(Japan)*

Sci. Rev. (Manila)
*Science Review (Manila) *(Philippines)*

Sci. Sinica (Peking)
*Scientia Sinica (Peking) (Chung Kuo K'o Hsueh) *(China)*

Sci. World
Scientific World *(England)*

Scot. Med. J.
Scottish Medical Journal *(Scotland)*

Scripta Med. Fac. Med. Univ. Brun. Olomuc.
Scripta Medica Facultatum Medicinae Universitatum Brunensis et Olomucencis *(Czechoslovakia)*

Seikagaku
Seikagaku (Biochemistry) *(Japan)*

Seiken Jiho
*Seiken Jiho (Reports of the Kihara Inst. for Biological Research) *(Japan)*

Seisan-Kenkyu
Seisan-Kenkyu (Industrial Production Research) *(Japan)*

Sekiyu Gijutsu Kyokaishi
Sekiyu Gijutsu Kyokaishi (Journal of the Japanese Association of Petroleum Technologists) *(Japan)*

Semaine Hop. Paris
Semaine des Hopitaux de Paris, La *(France)*

Semaine Med. Profess. Med.-Soc.
Semaine Medicale Professionnelle et Medico-Sociale *(France)*

Semana Med. (Buenos Aires)
Semana Medica, La (Buenos Aires) *(Argentina)*

Setchaku
Setchaku (Adhesion and Adhesives) *(Japan)*

Sheet Metal Ind.
Sheet Metal Industries incorporating Press Tool Engineering *(England)*

Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao
Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao (Acta Biochimica et Biophysica Sinica) *(China)*

Shih Yen Sheng Wu Hsueh Pao
Shih Yen Sheng Wu Hsueh Pao (Acta Biologiae Experimentalis Sinica) *(China)*

Shikoku Acta Med.
Shikoku Acta Medica
see *Shikoku Igaku Zasshi*

Shikoku Igaku Zasshi
*Shikoku Igaku Zasshi (Shikoku Acta Medica) *(Japan)*

Shinku Kagaku
Shinku Kagaku (Vacuum Chemistry) *(Japan)*

Shitsuryo Bunseki
Shitsuryo Bunseki (Mass Spectroscopy (Tokyo)) *(Japan)*

Showa Densen Denran Rebyu
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*

Showa Wire Cable Rev.
Showa Wire and Cable Review
see *Showa Densen Denran Rebyu*

SIAM (Soc. Ind. Appl. Math.) Rev.
SIAM (Society for Industrial and Applied Mathematics) Review *(U. S.)*

Sibirsk. Mat. Zh.
Sibirskii Matematicheskii Zhurnal *(U.S.S.R.)*

Siemens-Z.
Siemens-Zeitschrift *(Germany)*

Silikaty
Silikaty *(Czechoslovakia)*

Sitzber. Deut. Akad. Wiss. Berlin, Kl. Bergbau, Huettenwesen Montangeol.
Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fuer Bergbau, Huettenwesen und Montangeologie *(Germany)*

Sitzber. Ges. Befoerder. Ges. Naturw. Marburg
*Sitzungsberichte der Gesellschaft zur Befoerderung der Gesamten Naturwissenschaften zu Marburg *(Germany)*

Skin
Skin *(U. S.)*

Sklar Keram.
Sklar a Keramik *(Czechoslovakia)*

Soc. Sci. Fennica, Commentationes Phys.-Math.
Societas Scientiarum Fennica, Commentationes Physico-Mathematicae *(Finland)*

Sogo Igaku
Sogo Igaku (Medicine) *(Japan)*

Sogo Rinsho
Sogo Rinsho (Clinics All-round (Osaka)) *(Japan)*

Sogo Shikensho Nempo
Sogo Shikensho Nempo (Annual Report of the Engineering Research Institute) *(Japan)*

Soil Sci.
*Soil Science *(U. S.)*

Soil Sci. Soc. Am., Proc.
*Soil Science Society of America, Proceedings *(U. S.)*

Solid State Commun.
*Solid State Communications *(U. S.)*

Solid State Phys.
*Solid State Physics *(U. S.)*

Soobshch. Akad. Nauk Gruz. SSR
Soobshcheniya Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Soryushiron Kenkyu
Soryushiron Kenkyu (Study of Elementary Particles) *(Japan)*

Southeastern Geol.
Southeastern Geology *(U. S.)*

Southern Med. J.
Southern Medical Journal *(U. S.)*

Soviet Astron. AJ (English Transl.)
*Soviet Astronomy–AJ (English Translation of Astronomicheskii Zhurnal) *(U. S.)*

Soviet J. Nucl. Phys. (English Transl.)
Soviet Journal of Nuclear Physics (English Translation of Yadernaya Fizika) *(U. S.)*

Soviet Phys.–Cryst. (English Transl.)
*Soviet Physics–Crystallography (English Translation of Kristallografiya) *(U. S.)*

Soviet Phys.-Solid State (English Transl.)
*Soviet Physics–Solid State (English translation of Fizika Tverdogo Tela) *(U. S.)*

Soviet Powder Met. Metal Ceram. (English Transl.)
Soviet Powder Metallurgy and Metal Ceramics (English Translation of Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR) *(U. S.)*

Soviet Soil Sci. (English Transl.)
Soviet Soil Science (English Translation of Pochvovedenie) *(U. S.)*

Sov. Med.
Sovetskaya Meditsina *(U.S.S.R.)*

Space/Aeron.
*Space/Aeronautics *(U. S.)*

Spaceflight
Spaceflight *(England)*

Space Sci. Rev.
*Space Science Reviews *(Netherlands)*

Spectrochim. Acta
*Spectrochimica Acta *(England)*

Sperimentale
Sperimentale, Lo *(Italy)*

SPE (Soc. Plastics Engrs.) Trans.
SPE (Society of Plastics Engineers) Transactions *(U. S.)*

Srpski Arhiv Celokupno Lekar.
Srpski Arhiv za Celokupno Lekarstvo *(Yugoslavia)*

Stahl Eisen
Stahl und Eisen *(Germany)*

Stain Technol.
Stain Technology *(U. S.)*

Stal
Stal† *(U.S.S.R.)*

Staub
*Staub *(Germany)*

Steam Heating Engr.
Steam and Heating Engineer, The (incorporating The Steam Engineer, Heating and The Industrial Heating Engineer) *(England)*

Steroids
Steriods *(U. S.)*

Stomatologiya
Stomatologiya *(U.S.S.R.)*

Strahlentherapie
*Strahlentherapie *(Germany)*

Strahlentherapie, Sonderbaende
*Strahlentherapie, Sonderbaende *(Germany)*

Strasbourg Med.
Strasbourg Medical *(France)*

Stroit. Materiali Silikat. Prom.
Stroitelni Materiali i Silikatna Promishlenost *(Bulgaria)*

Studia Math.
*Studia Mathematica *(Poland)*

Studia Univ. Babes-Bolyai, Ser. Biol.
Studia Universitatis Babes-Bolyai, Series Biologia *(Romania)*

Studia Univ. Babes-Bolyai, Ser. Chem.
*Studia Universitatis Babes-Bolyai, Series Chemia *(Romania)*

Studia Univ. Babes-Bolyai, Ser. Math.-Phys.
*Studia Universitatis Babes-Bolyai, Series Mathematica-Physica *(Romania)*

Studii Cercetari Endocrinol.
Studii si Cercetari de Endocrinologie (formerly Academia Republicii Populare Romine, Institutul de Endocrinologie "Prof. C. I. Parhon," Studii si Cercetari de Endocrinologie) *(Romania)*

Studii Cercetari Fiz.
*Studii si Cercetari de Fizica (formerly Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica) *(Romania)*

Studi Sassaresi, Sez. I
Studi Sassaresi, Sezione I *(Italy)*

Studium Gen.
Studium Generale *(Germany)*

Study Elem. Particles (Japan)
Study of Elementary Particles (Japan)
see *Soryushiron Kenkyu*

Sulzer Tech. Rev. (Switz.)
*Sulzer Technical Review *(Switzerland)*

Sumitomo Denki
Sumitomo Denki (Sumitomo Electric Review) *(Japan)*

Sumitomo Elec. Rev.
Sumitomo Electric Review
see *Sumitomo Denki*

Sumitomo Keikinzoku Giho
Sumitomo Keikinzoku Giho (Sumitomo Light Metals Technical

Reports) *(Japan)*
Sumitomo Light Metals Tech. Rept.
Sumitomo Light Metals Technical Reports
see Sumitomo Keikinzoku Giho
Suomen Kemistilehti, B
Suomen Kemistilehti, Section B *(Finland)*
Surface Sci.
Surface Science *(Netherlands)*
Surg. Clin. N. Am.
Surgical Clinics of North America, The *(U. S.)*
Surgery
Surgery *(U. S.)*
Surg. Forum
Surgical Forum *(U. S.)*
Surg., Gynecol. Obstet.
Surgery, Gynecology and Obstetrics with International Abstracts of Surgery *(U. S.)*
Suvremenna Med.
Suvremenna Meditsina *(Bulgaria)*
Svarochn. Proizv.
Svarochnoe Proizvodstvo† *(U.S.S.R.)*
Svensk Farm. Tidskr.
Svensk Farmaceutisk Tidskrift *(Sweden)*
Svensk Kem. Tidskr.
Svensk Kemisk Tidskrift *(Sweden)*
Symp. Intern. Soc. Cell Biol.
Symposia of the International Society for Cell Biology *(U. S.)*
Tabacco
Tabacco, Il *(Italy)*
Ta Han Hua Hsueh Hui-Chih
Ta Han Hua Hsueh Hui-Chih (Journal of the Korean Chemical Society) *(Korea)*
Taiki Hoshano Kansoku Seisoki
*Taiki Hoshano Kansoku Seisoki (Bulletin of the Atmospheric Radioactivity) *(Japan)*
T'ai-wan I Hsueh Hui Tsa Chih
T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China)*
Talanta
*Talanta *(England)*
Tech. Bull., Egypt. Agr. Organ.
Technical Bulletin, Egyptian Agricultural Organization *(Egypt)*
Tech. Commun., Dept. Agr. Tech. Serv. (S. Africa)
Technical Communication, Department of Agricultural Technical Services (South Africa) *(S. Africa)*
Tech. Dig. (Prague)
Technical Digest, A Monthly Review of Technology and Science in Socialist Countries (Prague) *(Czechoslovakia)*
Tech. Hosp. (Paris)
Techniques Hospitalieres, Medico-Sociales et Sanitaires (Paris) *(France)*
Tech. Mitt. Krupp. Forschungsber.
*Technische Mitteilungen Krupp. Forschungsberichte *(Germany)*
Tech. Mod.
Technique Moderne; Revue Universelle des Sciences Appliquees a l'Industrie *(France)*
Technologist
Technologist *(U. S.)*
Technol. Rept. Osaka Univ.
Technology Reports of the Osaka University *(Japan)*
Technol. Rept. Tohoku Univ.
Technology Reports of the Tohoku University, The *(Japan)*
Tech. Rept. Eng. Res. Inst., Kyoto Univ.
*Technical Reports of the Engineering Research Institute, Kyoto University *(Japan)*
Tech. Rept. ISSP, Ser. A
Technical Report of ISSP, Series A *(Japan)*
Tech. Ueberwach.
*Technische Ueberwachung *(Germany)*
Tech. Zpravodaj
Technicky Zpravodaj *(Czechoslovakia)*
Tehnika (Belgrade)
Tehnika (Belgrade) *(Yugoslavia)*
Tehn. ja Tootmine
Tehnika ja Tootmine *(Estonian S.S.R.)*
Tekhn. Molodezhi
Tekhnika Molodezhi *(U.S.S.R.)*
Tek. Tidskr.
Teknisk Tidskrift *(Sweden)*
Telefunken Ztg.
*Telefunken Zeitung *(Germany)*
Tellus
*Tellus. A Quarterly Journal of Geophysics *(Sweden)*
Teor. i Eksperim. Khim.
*Teoreticheskaya i Eksperimentalnaya Khimiya *(Ukrainian S.S.R.)*
Teploenergetika
*Teploenergetika *(U.S.S.R.)*
Teplofiz. Vysokikh Temp.
*Teplofizika Vysokikh Temperatur† *(U.S.S.R.)*
Teplo i Massoperenos, Pervoe Vses. Soveshch., Minsk, 1961
Teplo i Massoperenos, Pervoe Vsesoyuznoe Soveshchanie, Minsk, June 5–9, 1961, Vol. 1 (Pub. 1962) *(Belorussian S.S.R.)*
Terapevt. Arkh.
Terapevticheskii Arkhiv *(U.S.S.R.)*
Terebijon
Terebijon (The Journal of the Institute of Television Engineers of Japan) *(Japan)*
Termotecnica (Milan)
Termotecnica, La (Milan) *(Italy)*
Tetrahedron
*Tetrahedron *(Northern Ireland)*
Tetrahedron Letters
Tetrahedron Letters *(Northern Ireland)*
Tetsu To Hagane
Tetsu To Hagane (Journal of the Iron and Steel Institute) *(U. S.-Japan)*
Texas J. Sci.
Texas Journal of Science, The *(U. S.)*
Texas Rept. Biol. Med.
*Texas Reports on Biology and Medicine *(U. S.)*
Texas State J. Med.
Texas State Journal of Medicine *(U. S.)*
Textile Res. J.
Textile Research Journal *(U. S.)*
Therapie
Therapie *(France)*
Therapia Hung.
Therapia Hungarica *(Hungary)*
Therapie Gegenwart
Therapie der Gegenwart *(Germany)*
Therap. Umschau
Therapeutische Umschau und Medizinische Bibliographie *(Switzerland)*
Thermal Power (Japan)
Thermal Power (Japan), The
see Karyoku Hatsuden
Thorax
Thorax *(England)*
Thromb. Diath. Haemorrhag.
Thrombosis et Diathesis Haemorrhagica *(Germany)*
Ti Ch'iu Wu Li Hsueh Pao
*Ti Ch'iu Wu Li Hsueh Pao (Acta Geophysica Sinica) *(China)*
Tidskr. Mil. Halsovard
Tidskrift i Militar Halsovard *(Sweden)*
Tidsskr. Kjemi, Bergvesen Met.
*Tidsskrift for Kjemi, Bergvesen og Metallurgi *(Norway)*
Tidsskr. Norske Laegeforen.
Tidsskrift for den Norske Laegeforening *(Norway)*
Tien Wen Hsueh Pao
Tien Wen Hsueh Pao (Acta Astronomica Sinica) *(China)*
Tijdschr. Diergeneesk.
Tijdschrift voor Diergeneeskunde *(Netherlands)*
Tijdschr. Sociale Geneesk.
Tijdschrift voor Sociale Geneeskunde *(Netherlands)*
Tobacco
Tobacco (includes a special section, Tobacco Science) *(U. S.)*
Tobacco Sci.
Tobacco Science (published as a special section in Tobacco) *(U. S.)*
Tohoku Igaku Zasshi
Tohoku Igaku Zasshi (Tohoku Medical Journal) *(Japan)*
Tohoku J. Exptl. Med.
Tohoku Journal of Experimental Medicine, The *(Japan)*
Tohoku Med. J.
Tohoku Medical Journal
see Tohoku Igaku Zasshi
Tokushima J. Exptl. Med.
*Tokushima Journal of Experimental Medicine, The *(Japan)*
Tokyo Daigaku Koku Kenkyusho Shuho
Tokyo Daigaku Koku Kenkyusho Shusho (Bulletin of the Aeronautical Research Institute, University of Tokyo) *(Japan)*

Tokyo Igaku Zasshi
Tokyo Igaku Zasshi (The Tokyo Journal of Medical Science) *(Japan)*

Tokyo J. Med. Sci.
Tokyo Journal of Medical Science, The
see Tokyo Igaku Zasshi

Tokyo Kogyo Shikensho Hokoku
*Tokyo Kogyo Shikensho Hokoku (Reports of the Government Chemical Industrial Research Institute, Tokyo) *(Japan)*

Tonind. Ztg. Keram. Rundschau
Tonindustrie-Zeitung und Keramische Rundschau *(Germany)*

Tool Mfg. Engr.
Tool and Manufacturing Engineer, The *(U. S.)*

Torax
*Torax *(Uruguay)*

Toshiba Rebyu
Toshiba Rebyu (Toshiba Review) *(Japan)*

Toshiba Rev.
Toshiba Review
see Toshiba Rebyu

Toshiba Rev., Intern. Ed.
*Toshiba Review, International Edition *(Japan)*

Toulouse Med.
Toulouse Medical *(France)*

Toxicol. Appl. Pharmacol.
Toxicology and Applied Pharmacology *(U. S.)*

Trans. AIME, Met. Soc.
Transactions of AIME, Metallurgical Society
see Trans. Met. Soc. AIME

Trans. Am. Acad. Ophthalmol. Otolaryngol.
Transactions of the American Academy of Ophthalmology and Otolaryngology *(U. S.)*

Trans. Am. Clin. Climatol. Assoc.
Transactions of the American Clinical and Climatological Association *(U. S.)*

Trans. Am. Foundrymen's Soc.
Transactions of the American Foundrymen's Society *(U. S.)*

Trans. Am. Geophys. Union
*Transactions of the American Geophysical Union *(U. S.)*

Trans. Am. Nucl. Soc.
*Transactions of the American Nuclear Society *(U. S.)*

Trans. Am. Soc. Metals
Transactions of the American Society for Metals *(U. S.)*

Trans. ASAE (Am. Soc. Agr. Engrs.)
Transactions of the ASAE (American Society of Agricultural Engineers) *(U. S.)*

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. A: J. Eng. Power
Transactions of the ASME (American Society of Mechanical Engineers), Series A: Journal of Engineering for Power
see J. Eng. Power

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. C: J. Heat Transfer
Transactions of the ASME (American Society of Mechanical Engineers), Series C: Journal of Heat Transfer
see J. Heat Transfer

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. D: J. Basic Eng.
Transactions of the ASME (American Society of Mechanical Engineers), Series D: Journal of Basic Engineering
see J. Basic Eng.

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. E: J. Appl. Mech.
Transactions of the ASME (American Society of Mechanical Engineers), Series E: Journal of Applied Mechanics
see J. Appl. Mech.

Trans. Bose Res. Inst. (Calcutta)
*Transactions of the Bose Research Institute (Calcutta) *(India)*

Trans. Brit. Ceram. Soc.
*Transactions of the British Ceramic Society incorporating British Ceramic Abstracts *(England)*

Trans. Can. Inst. Mining Met.
*Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia *(Canada)*

Trans. Chalmers Univ. Technol., Gothenburg
*Transactions of Chalmers University of Technology, Gothenburg, Sweden *(Sweden)*

Trans. Coll. Physicians Philadelphia
Transactions of the College of Physicians of Philadelphia *(U. S.)*

Trans. Eng. Inst. Can.
*Transactions of the Engineering Institute of Canada *(Canada)*

Trans. Faraday Soc.
*Transactions of the Faraday Society *(England)*

Trans. Indian Inst. Metals
Transactions of the Indian Institute of Metals *(India)*

Trans. Inst. Chem. Engrs. (London)
Transactions of the Institution of Chemical Engineers (London) *(England)*

Trans. Inst. Mining Met.
Transactions of the Institution of Mining and Metallurgy (published with the Bulletin of the Institution of Mining and Metallurgy *(England)*

Trans. Japan Inst. Metals
*Transactions of the Japan Institute of Metals (Sendai) *(Japan)*

Trans. Japan Soc. Mech. Engrs.
Transactions of the Japan Society of Mechanical Engineers
see Nippon Kikai Gakkai Rombunshu

Trans. Met. Soc. AIME
*Transactions of the Metallurgical Society of AIME (American Institute of Mining, Metallurgical, and Petroleum Engineers) *(U. S.)*

Trans. Natl. Res. Inst. Metals (Tokyo)
Transactions of National Research Institute for Metals (Tokyo) *(Japan)*

Trans. N. Y. Acad. Sci.
*Transactions of the New York Academy of Sciences *(U. S.)*

Trans. Opthalmol. Soc. Australia
Transactions of the Opthalmological Society of Australia *(Australia)*

Transplantation
*Transplantation (formerly Transplantation Bulletin) *(U. S.)*

Trans. Roy. Inst. Technol., Stockholm
Transactions of the Royal Institute of Technology, Stockholm, Sweden *(Sweden)*

Trans. Roy. Soc. Can.
*Transactions of the Royal Society of Canada *(Canada)*

Trans. Studies Coll. Physicians Phila.
Transactions and Studies of the College of Physicians of Philadelphia *(U. S.)*

Travaux
Travaux *(France)*

Treatise Anal. Chem.
Treatise on Analytical Chemistry *(U. S.)*

Trend Eng. Univ. Wash.
*Trend in Engineering at the University of Washington *(U. S.)*

Tr. Energ. Inst., Akad. Nauk Azerb. SSR
*Trudy Energeticheskogo Instituta imeni I. G. Es'mana, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Erevansk. Zootekhn. Vet. Inst.
Trudy Erevanskogo Zootekhniko-Veterinarnogo Instituta *(Armenian S.S.R.)*

Tr. Fiz. Inst., Akad. Nauk SSSR
*Trudy Fizicheskogo Institute imeni P. N. Lebedeva, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Gl. Geofiz. Observ.
Trudy Glavnoi Geofizicheskoi Observatorii imeni A. I. Voeikova *(U.S.S.R.)*

Tr., Gos. Inst. Prikl. Khim.
Trudy, Gosudarstvennyi Institut Prikladnoi Khimii *(U.S.S.R.)*

Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Uralsk. Filial
Trudy Instituta Elektrokhimii, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Azerb. SSR
*Trudy Instituta Fiziki, Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Gruz. SSR
*Trudy Instituta Fiziki, Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Latv. SSR
*Trudy Instituta Fiziki, Akademiya Nauk Latviiskoi SSR *(Latvian S.S.R.)*

Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR
*Trudy Instituta Fiziki i Astronomii, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*

Tr. Inst. Fiziol., Akad. Nauk Gruz. SSR
Trudy Instituta Fiziologii, Akademiya Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Genet., Akad. Nauk SSSR
Trudy Instituta Genetiki, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Geol. Nauk, Akad. Nauk Kaz. SSR
*Trudy Instituta Geologicheskikh Nauk, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR
Trudy Instituta Metallurgii imeni A. A. Baikova, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Yadern. Fiz., Akad. Nauk Kaz. SSR
*Trudy Instituta Yadernoi Fiziki, Akademiya Nauk Kazakhskoi

SSR *(Kazakh S.S.R.)*

Tr. Kazakhsk. Nauchn.-Issled. Inst. Mineral'n. Syr'ya
Trudy Kazakhskogo Nauchno-Issledovatel'skogo Instituta Mineral'nogo Syr'ya *(Kazakh S.S.R.)*

Tr. Kishinevsk. Gos. Med. Inst.
Trudy Kishinevskogo Gosudarstvennogo Meditsinskogo Instituta *(U.S.S.R.)*

Tr. Komis. po Analit. Khim., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim.
Trudy Komissii po Analiticheskoi Khimii, Akademiya Nauk SSSR, Institut Geokhimii i Analiticheskoi Khimii imeni V. I. Vernadskogo *(U.S.S.R.)*

Tr., Kuibyshevsk. Aviats. Inst.
Trudy, Kuibyshevskii Aviatsionnyi Institut *(U.S.S.R.)*

Tr. Lab. Geol. Dokembriya, Akad. Nauk SSSR
Trudy Laboratorii Geologii Dokembriya, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Leningr. Politekhn. Inst.
Trudy Leningradskogo Politekhnicheskogo Instituta imeni M. I. Kalinina *(U.S.S.R.)*

Tr. Mat. Inst., Akad. Nauk SSSR
*Trudy Matematicheskogo Instituta imeni V. A. Steklova, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Mezhdunar. Konf. po Uskoritelyam, Dubna, 1963
Trudy Mezhdunarodnoi Konfrentsii po Uskoritelyam, Dubna, August 21-27, 1963 (Pub. 1964) *(U.S.S.R.)*

Tr., Mosk. Inst. Neftekhim. i Gaz. Prom.
Trudy, Moskovskii Institut Neftekhimicheskoi i Gazovoi Promyshlennosti imeni I. M. Gubkina *(U.S.S.R.)*

Tr. Nauchn.-Issled. Fiz.-Khim. Inst.
Trudy Nauchno-Issledovatel'skogo Fiziko-Khimicheskogo Instituta imeni L. Ya. Karpova *(U.S.S.R.)*

Tr. Nauchn.-Issled. Inst. Gidrometeorol. Priborostr.
Trudy Nauchno-Issledovatel'skogo Instituta Gidrometeorologicheskogo Priborostroeniya *(U.S.S.R.)*

Tr., Nauchn.-Issled. Inst. Sintetich. Zhirozamenitelei i Moyushchikh Sredstv
Trudy, Nauchno-Issledovatel'skii Institut Sinteticheskikh Zhirozamenitelei i Moyushchikh Sredstv *(U.S.S.R.)*

Tr. Novocherk. Politekhn. Inst.
Trudy Novocherkasskogo Politekhnicheskogo Instituta imeni Sergo Ordzhonikidze *(Armenian S.S.R.)*

Tr. Shemakhinsk. Astrofiz. Observ., Akad. Nauk Azerb. SSR
*Trudy Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Vses. Nauchn. Meteorol. Soveshch.
Trudy Vsesoyuznogo Nauchnogo Meteorologicheskogo Soveshchaniya *(U.S.S.R.)*

Tr. 2-oi [Vtoroi] Nauchn. Konf. po Vopr. "Probl. Zhira v Pitanii," Leningrad, 1962
Trudy 2-oi [i.e. Vtoroi] Nauchnoi Konferentsii po Voprusu "Problema Zhira v Pitanii," Leningrad, 1962 *(U.S.S.R.)*

Tsitologiya
Tsitologiya† *(U.S.S.R.)*

Tsvetn. Metal.
*Tsvetnye Metally† *(U.S.S.R.)*

Tumori
*Tumori *(Italy)*

Tung Wu Hsueh Pao
Tung Wu Hsueh Pao (Acta Zoologica Sinica) *(China)*

Turk Tip Cemiyeti Mecmuasi
Turk Tip Cemiyeti Mecmuasi *(Turkey)*

TVF (Tek. Vetenskaplig Forskning)
*TVF (Teknisk-Vetenskaplig Forskning) *(Sweden)*

Uchusen-Kenkyu
Uchusen-Kenkyu *(Japan)*

Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk
Uchenye Zapiski Azerbaidzhanskogo Gosudarstvennogo Universiteta imeni S. M. Kirova, Seriya Khimicheskikh Nauk *(Azerbaidzhan S.S.R.)*

Uch. Zap., Khar'kovsk. Gos. Univ., Tr. Biol. Fak.
Uchenye Zapiski, Khar'kovskii Gosudarstvennyi Universitet imeni A. M. Gor'kogo, Trudy Biologicheskogo Fakul'teta *(Ukrainian S.S.R.)*

Uch. Zap., Kuibyshevsk. Gos. Ped. Inst.
Uchenye Zapiski, Kuibyshevskii Gosudarstvennyi Pedagogicheskii Institut imeni V. V. Kuibysheva *(Uzbek S.S.R.)*

Uch. Zap., Permsk. Gos. Univ.
Uchenye Zapiski, Permskii Gosudarstvennyi Universitet imeni A. M. Gor'kogo *(U.S.S.R.)*

Ukr. Biokhim. Zh.
*Ukrainskii Biokhimichnii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Fiz. Zh.
*Ukrainskii Fizichnii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Khim. Zh.
*Ukrainskii Khimicheskii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Mat. Zh.
*Ukrainskii Matematicheskii Zhurnal *(Ukrainian S.S.R.)*

Umweltradioakt. Strahlenbelast.
*Umweltradioaktivitaet und Strahlenbelastung *(Germany)*

Union Med. Can.
*Union Medicale du Canada, L' *(Canada)*

Univ. Bruxelles, Inst. Phys., Bull.
*Universite de Bruxelles, Institut de Physique, Bulletin *(Belgium)*

Univ. Mich. Med. Bull.
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Univ. Roorkee Res. J.
University of Roorkee Research Journal *(India)*

Urania (Krakow)
*Urania (Krakow) *(Poland)*

Urol. Intern.
Urologia Internationalis *(Switzerland)*

U. S. Fish Wildlife Serv., Fishery Bull.
United States Fish and Wildlife Service, Fishery Bulletin *(U. S.)*

Usp. Fiz. Nauk
*Uspekhi Fizicheskikh Nauk† *(U.S.S.R.)*

Usp. Khim.
*Uspekhi Khimii† *(U.S.S.R.)*

Usp. Sovrem. Biol.
Uspekhi Sovremennoi Biologii *(U.S.S.R.)*

Uzbeksk. Biol. Zh.
Uzbekskii Biologicheskii Zhurnal, Akademiya Nauk Uzbekskoi SSR *(Uzbek S.S.R.)*

Vacuum
Vacuum *(U. S.)*

Vacuum Chem. (Tokyo)
Vacuum Chemistry (Tokyo)
see Shinku Kagaku

Vaisala News
Vaisala News *(Finland)*

Vakuum-Tech.
*Vakuum-Technik *(Germany)*

Va. Med. Monthly
Virginia Medical Monthly *(U. S.)*

Va. Polytech. Inst., Eng. Ext. Ser. Circ.
Virginia Polytechnic Institute, Engineering Extension Series Circular *(U. S.)*

Vascular Diseases
Vascular Diseases *(U. S.)*

Vazduhoplovni Glasnik
Vazduhoplovni Glasnik *(Yugoslavia)*

VDI (Ver. Deut. Ingr.) -Forschungsh.
VDI (Verein Deutscher Ingenieure) -Forschungsheft *(Germany)*

VDI (Ver. Deut. Ingr.) Z.
*VDI (Verein Deutscher Ingenieure) Zeitschrift *(Germany)*

Verhandl. Deut. Ges. Pathol.
*Verhandlungen der Deutschen Gesellschaft fuer Pathologie *(Germany)*

Verhandl. Intern. Ver. Theoret. Angew. Limnol.
Verhandlungen der Internationalen Vereinigung fuer Theoretische und Angewandte Limnologie *(Germany)*

Vestn. Akad. Med. Nauk SSSR
Vestnik Akademii Meditsinskikh Nauk SSSR *(U.S.S.R.)*

Vestn. Akad. Nauk Kaz. SSR
*Vestnik Akademii Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Vestn. Akad. Nauk SSSR
*Vestnik Akademii Nauk SSSR *(U.S.S.R.)*

Vestn. Dermatol. i Venerol.
Vestnik Dermatologii i Venerologii *(U.S.S.R.)*

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Vestnik Leningradskogo Universiteta, Seriya Biologii *(U.S.S.R.)*

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*Vestnik Leningradskogo Universiteta, Seriya Fiziki i Khimii *(U.S.S.R.)*

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*Vestnik Leningradskogo Universiteta, Seriya Geologii i Geografii *(U.S.S.R.)*

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*Vestnik Leningradskogo Universiteta, Seriya Matematiki, Mekhaniki i Astronomii *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. II: Khim.
*Vestnik Moskovskogo Universiteta, Seriya II: Khimiya (formerly a part of Vestnik Moskovskogo Universiteta, Seriya

Matematiki, Mekhaniki, Astronomii, Fiziki i Khimii) *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. III: Fiz. Astron.
*Vestnik Moskovskogo Universiteta, Seriya III. Fiziki, Astronomii *(U.S.S.R.)*

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Vestnik Moskovskogo Universiteta, Seriya IV: Geologiya *(U.S.S.R.)*

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Vestnik Moskovskogo Universiteta, Seriya VI: Biologiya, Pochvovedenie *(U.S.S.R.)*

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Vestn. Otorino-Laringol.
Vestnik Otorino-Laringologii *(U.S.S.R.)*

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Vestnik Rentgenologii i Radiologii *(U.S.S.R.)*

Vestn. Sel'skokhoz. Nauki, Vses. Akad. Sel'skokhoz. Nauk
Vestnik Sel'skokhozyaistvennoi Nauki, Vsesoyuznaya Akademiya Sel'skokhozyaistvennykh Nauk imeni V. I. Lenina *(U.S.S.R.)*

Vestsi Akad. Navuk Belarusk. SSR, Ser. Biyal. Navuk
Vestsi Akademii Navuk Belaruskai SSR, Seryya Biyalagichnykh Navuk *(Belorussian S.S.R.)*

Veszpremi Vegyip. Egyet. Kozlemen.
Veszpremi Vegyipari Egyetem Kozlemenyei, A *(Hungary)*

Vet. Med. (Prague)
Veterinari Medicina (Prague) *(Czechoslovakia)*

Vide
*Vide, Le, Technique-Applications *(France)*

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Vie Medicale *(France)*

Vierteljahresschr. Schweiz. Sanitaetsoffiziere
Vierteljahrsschrift fuer Schweizerische Sanitaetsoffiziere *(Switzerland)*

Vijnana Parishad Anusandhan Patrika
*Vijnana Parishad Anusandhan Patrika *(India)*

Vinyl Japan
Vinyl Japan
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Virology *(U. S.)*

Vitamins (Kyoto)
Vitamins (Kyoto)
see **Bitamin**

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Vnitrni Lekarstvi *(Czechoslovakia)*

Voenno-Med. Zh.
Voenno-Meditsinskii Zhurnal *(U.S.S.R.)*

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Voennye Znaniya *(U.S.S.R.)*

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Vojenske Zdravotnicke Listy *(Czechoslovakia)*

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Vojnosanitetski Pregled *(Yugoslavia)*

Vopr. Biol. i Kraevoi Med., Akad. Nauk Uz. SSR, Otd. Biol. Nauk
Voprosy Biologii i Kraevoi Meditsiny, Akademiya Nauk Uzbekskoi SSR, Otdelenie Biologicheskikh Nauk *(Uzbek S.S.R.)*

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Voprosy Dozimetrii i Zashchity ot Izluchenii, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

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*Voprosy Fiziologii, Akademiya Nauk Azerbaidzhanskoi SSR, Sektor Fiziologii *(Azerbaidzhan S.S.R.)*

Vopr. Ikhtiol.
Voprosy Ikhtiologii *(U.S.S.R.)*

Vopr. Kosmogonii, Akad. Nauk SSSR
Voprosy Kosmogonii, Akademiya Nauk SSSR *(U.S.S.R.)*

Vopr. Med. Khim.
Voprosy Meditsinskoi Khimii *(U.S.S.R.)*

Vopr. Onkol.
*Voprosy Onkologii *(U.S.S.R.)*

Vopr. Pitaniya
Voprosy Pitaniya *(U. S. S. R.)*

Vopr. Radiobiol., Sb. Tr.
*Voprosy Radiobiologii, Sbornik Trudov *(Armenian S.S.R.)*

Vopr. Rudn. Geofiz., Min. Geol. i Okhrany Nedr SSSR
Voprosy Rudnoi Geofiziki, Ministerstvo Geologii i Okhrany Nedr SSSR *(U.S.S.R.)*

Vrachebnoe Delo
Vrachebnoe Delo *(Ukrainian S.S.R.)*

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*Vysokomolekulyarnye Soedineniya† *(U.S.S.R.)*

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Waseda Daigaku Rikogaku Kenkyusho Hokoku (Bulletin of Scientific and Engineering Research Laboratory, Waseda University) *(Japan)*

Wasser, Luft Betrieb
Wasser, Luft und Betrieb *(Germany)*

Water, Bodem, Lucht
Water, Bodem, Lucht *(Netherlands)*

Water Resources Res.
Water Resources Research *(U. S.)*

Water Works Eng.
Water Works Engineering *(U. S.)*

Wear
Wear *(Netherlands)*

Welding J. (N. Y.)
*Welding Journal, The (New York) *(U. S.)*

Welding Prod. (USSR) (English Transl.)
Welding Production (USSR) (English Translation of Svarochnoe Proizvodstvo) *(England)*

Welding Tech.
Welding Technique
see **Yosetsu Gijutsu**

Werkstoffe Korrosion
Werkstoffe und Korrosion *(Germany)*

Western Machinery Steel World
Western Machinery and Steel World *(U. S.)*

Westinghouse Engr.
Westinghouse Engineer *(U. S.)*

Wetter Leben
Wetter und Leben *(Austria)*

Wheat Inform. Serv. (Japan)
Wheat Information Service *(Japan)*

Wiadomosci Chemi.
*Wiadomosci Chemiczne *(Poland)*

Wien. Klin. Wochschr.
Wiener Klinische Wochenschrift *(Austria)*

Wien. Med. Wochschr.
Wiener Medizinische Wochenschrift *(Austria)*

Wien. Tieraerztl. Monatsschr.
Wiener Tieraerztliche Monatsschrift *(Austria)*

Wien. Z. Inn. Med. Grenzg.
Wiener Zeitschrift fuer Innere Madizin und ihre Grenzgebiete *(Austria)*

Wire Ind.
Wire Industry *(England)*

Wire Wire Prod.
Wire and Wire Products *(U. S.)*

Wisconsin Med. J.
Wisconsin Medical Journal *(U. S.)*

Wiss. Forschungsber. Naturw. Reihe
Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe *(Germany)*

Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturw. Reihe
Wissenschaftliche Zeitschrift der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(Germany)*

Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe
*Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(Germany)*

Wiss. Z. Martin-Luther-Univ. Halle-Wittenberg. Math. Naturw. Reihe
Wissenschaftliche Zeitschrift der Martin-Luther Universitaet Halle-Wittenberg, Mathematisch-Naturwissenschaftliche Reihe *(Germany)*

Wiss. Z. Techn. Univ. Dresden
Wissenschaftliche Zeitschrift der Technischen Universitaet Dresden (formerly Wissenschaftliche Zeitschrift der Technischen Hochschule Dresden) *(Germany)*

World Health Organ., Chron.
World Health Organization, Chronicle *(Switzerland)*

World Health Organ., Tech. Rept. Ser.
World Health Organization, Technical Report Series *(U. S.)*

World Obstet. Gynecol. (Tokyo)
World of Obstetrics and Gynecology (Tokyo), The
see **Sanfujinka No Sekai**

Wu Li Hsueh Pao
*Wu Li Hsueh Pao (Acta Physica Sinica) *(China)*

X-Ray Technician
X-Ray Technician, The *(U. S.)*
Yadern. Fiz.
*Yadernaya Fizika† *(U.S.S.R.)*
Yakugaku Zasshi
Yakugaku Zasshi (Journal of the Pharmaceutical Society of Japan) *(Japan)*
Yale J. Biol. Med.
*Yale Journal of Biology and Medicine, The *(U. S.)*
Yao Hsueh Hsueh Pao
Yao Hsueh Hsueh Pao (Acta Pharmaceutica Sinica) *(China)*
Yao Hsueh T'ung Pao
Yao Hsueh T'ung Pao (Bulletin of Pharmacology: Pharmacy Reports: Yaoxue Tongbao) *(China)*
Yaoxue Tongbao
Yaoxue Tongbao
see Yao Hsueh T'ung Pao
Yogyo Kyokai Shi
Yogyo Kyokai Shi (Journal of the Ceramic Association of Japan) *(Japan)*
Yokohama Med. Bull.
*Yokohama Medical Bulletin *(Japan)*
Yosetsu Gakkaishi
Yosetsu Gakkaishi (Journal of the Japan Welding Society) *(Japan)*
Yosetsu Gijutsu
Yosetsu Gijutsu (Welding Technique) *(Japan)*
Yosui To Haisui
Yosui To Haisui (Journal of Water and Waste) *(Japan)*
Z. Aerztl. Fortbild.
Zeitschrift fuer Aerztliche Fortbildung *(Germany)*
Z. Allgem. Mikrobiol.
Zeitschrift fuer Allgemeine Mikrobiologie, Morphologie, Physiologie und Oekologie der Mikroorganismen *(Germany)*
Z. Altersforsch.
*Zeitschrift fuer Altersforschung *(Germany)*
Z. Anal. Chem.
*Zeitschrift fuer Analytische Chemie, Fresenius' *(Germany)*
Z. Angew. Math. Mech.
*Zeitschrift fuer Angewandte Mathematik und Mechanik *(Germany)*
Z. Angew. Math. Phys.
*Zeitschrift fuer Angewandte Mathematik und Physik *(Switzerland)*
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*Zeitschrift fuer Angewandte Physik *(Germany)*
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*Zeitschrift fuer Anorganische und Allgemeine Chemie *(Germany)*
Zashita Metal.
*Zashita Metallov *(U.S.S.R.)*
Zastosowania Mat.
*Zastosowania Matematyki *(Poland)*
Z. Astrophys.
*Zeitschrift fuer Astrophysik *(Germany)*
Zavodsk. Lab.
*Zavodskaya Laboratoriya† *(U.S.S.R.)*
Z. Biol.
*Zeitschrift fuer Biologie *(Germany)*
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Zeitschrift fuer Chemie *(Germany)*
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Zdravotni Technika a Vzduchotechnika *(Czechoslovakia)*
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Zeitschrift fuer Elektrochemie *(Germany)*
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Zeitschrift fuer Zellforschung und Mikroskopische Anatomie *(Germany)*
Zentr. Allgem. Pathol. Pathol. Anat.
*Zentralblatt fuer Allgemeine Pathologie und Pathologische Anatomie *(Germany)*
Zentr. Arbeitsmed. Arbeitsschutz
Zentralblatt fuer Arbeitsmedizin und Arbeitsschutz *(Germany)*
Zentr. Bakteriol., Parasitenk., Abt. I. Orig.
Zentralblatt fuer Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, Abteilung I. Originale *(Germany)*
Zentr. Biol. Aerosol Forsch.
Zentralblatt fuer Biologische Aerosol Forschung *(Germany)*
Zentr. Gynaekol.
Zentralblatt fuer Gynaekologie *(Germany)*
Z. Erzbergbau Metallhuettenw.
Zeitschrift fuer Erzbergbau und Metallhuettenwesen *(Germany)*
Zeszyty Nauk. Politech. Lodz., Chem.
Zeszyty Naukowe Politechniki Lodzkiej, Chemia *(Poland)*
Zeszyty Nauk. Univ. Lodz., Ser. II
Zeszyty Naukowe Uniwersytetu Lodzkiego, Seria II *(Poland)*
Z. Geophys.
Zeitschrift fuer Geophysik *(Germany)*
Z. Ges. Exptl. Med.
*Zeitschrift fuer Gesamte Experimentelle Medizin Zugleich Fortsetzung der Zeitschrift fuer Experimentelle Pathologie und Therapie *(Germany)*
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Zeitschrift fuer die Gesamte Hygiene und Ihre Grenzgebiete *(Germany)*
Z. Ges. Inn. Med. Ihre Grenzgebiete
*Zeitschrift fuer die Gesamte Innere Medizine und Ihre Grenzgebiete *(Germany)*
Zh. Analit. Khim.
*Zhurnal Analiticheskoi Khimii† *(U.S.S.R.)*
Z. Haut-Geschlechtskrankh.
Zeitschrift fuer Haut- und Geschlechtskrankheiten *(Germany)*
Zh. Eksperim. i Teor. Fiz.
*Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki† *(U.S.S.R.)*
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*Zhurnal Fizicheskoi Khimii† *(U.S.S.R.)*
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Zhurnal Mikrobiologii, Epidemiologii i Immunobiologii† *(U.S.S.R.)*
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Zhurnal Vsesoyuznogo Khimicheskogo Obshchestva im. D. I. Mendeleeva *(U.S.S.R.)*
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*Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki *(U.S.S.R.)*
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Zeitschrift fuer Hygiene und Infektionskrankheiten *(Germany)*
Ziekenhuiswezen
Ziekenhuiswezen *(Netherlands)*
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Zeitschrift fuer Immunitaets- und Allergieforschung (formerly Zeitschrift fuer Immunitaetsforschung und Experimentelle Therapie) *(Germany)*
Z. Immunitaetsforsch.
Zeitschrift fuer Immunitaetsforschung und Experimentelle Therapie *(Germany)*
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Zeitschrift fuer Instrumentenkunde *(Germany)*
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Zeitschrift fuer Klinische Chemie *(Germany)*
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Zeitschrift fuer Naturwissenschaftlich-Medizinische Grundlagenforschung *(Switzerland)*
Zool. Mag. (Tokyo)
Zoological Magazine (Tokyo), The
see Dobutsugaku Zasshi
Zool. Zh.
Zoologicheskii Zhurnal *(U.S.S.R.)*
Z. *Orthopaed. Ihre Grenzgebiete*
Zeitschrift fuer Orthopaedie und Ihre Grenzgebiete *(Germany)*
Z. *Pflanzenernaehr. Dueng. Bodenk.*
Zeitschrift fuer Pflanzenernaehrung Duengung Bodenkunde *(Germany)*
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*Zeitschrift fuer Physik *(Germany)*
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*Zeitschrift fuer Physikalische Chemie (Frankfurt) *(Germany)*
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*Zeitschrift fuer Physikalische Chemie (Leipzig) *(Germany)*
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*Zeitschrift fuer Rheumaforschung *(Germany)*
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